EXD.

Bulletin 438

September, 1940

P. INST. ENT.
— LIBRARY —
1 1 JUN 1942
U.S.A.2
ATE

pp. 500-50

ANNUAL REPORT

for the

Year Ending October 31, 1939

Connecticut
Agricultural Experiment Station
New Haven

CONTENTS

Letter of Transmittal 490

Introduction

Connecticut Agriculture Faces New Frontiers 491
Emergencies in 1939 492
Staff Notes 492
New Buildings 493
Field Days 493
Publications 493

Wilton Everett Britton 494

Progress of the Station's Work

Analytical Chemistry 496
Biochemistry 497
Entomology 500
Forestry 509
Genetics (Plant Breeding) 513
Plant Pathology and Botany 516
Soils 520
Tobacco Substation 526
The Library 530

Publications 531

List of Active Projects, 1939-40 534

Report of the Treasurer 538

What the Station Can Do 551

LETTER OF TRANSMITTAL

December 15, 1939

To His Excellency
Raymond E. Baldwin,
Governor of Connecticut

Sir:

We have the honor to submit herewith the Annual Report of The Connecticut Agricultural Experiment Station for the year ended October 31, 1939. This is a brief statement in two parts:

1. A Report of Progress, which is in the form of the Report of the Director to the Board. This includes the list of publications for the year and the active projects arranged by departments.
2. The Report of the Treasurer for the fiscal year ended June 30, 1939.

Respectfully yours,

CONNECTICUT AGRICULTURAL EXPERIMENT STATION
THE BOARD OF CONTROL

E. C. Schneider, *Secretary*

REPORT OF THE DIRECTOR

FOR THE

YEAR ENDING OCTOBER 31, 1939

To the Board of Control of the Connecticut Agricultural Experiment Station:

CONNECTICUT may well look back with pride on the ingenuity of her citizens in many lines of endeavor. Not the least of the State's contributions have come through agricultural research, largely a part of the history of this Experiment Station. But to dwell too much on past accomplishment means stagnation. It is the future that challenges, the present emergency that stimulates. With solid foundations resting on experience and research, the Station looks forward to new frontiers in agriculture.

Connecticut must use her endowments to hold markets. We cannot compete with southern and western farmers in mass production, but we can make use of a climate and soil that will produce quality. Quality products will always find a market, especially in the Northeast with its concentration of wealth and population. In efforts to increase yield and to offer attractive fruits and vegetables, we have sometimes sacrificed flavor and delicacy. Yield and appearance are vitally important but we should not forget quality. Toward this end the Station has been and is working.

Connecticut must search for new outlets and new uses for her natural resources, and again the Station is prepared to act. When war broke out in Europe last month, our agronomists were immediately able to suggest a native substitute for the large amounts of peat moss commonly imported from Sweden and Germany. Connecticut swamp and bog land contains millions of tons of similar materials that may now be exploited. The Station has already tested the value of a number of these products from different sources.

Through a series of experiments at Windsor, a new use has been suggested for sandy fields that are no longer planted to tobacco and are not the best type for white potatoes. The Station found that large yields of sweet potatoes, a vegetable now shipped in quantities into the State from the South, can be obtained on these soils. The Connecticut farmer is particularly favored in growing this crop because our soil is free from diseases common on old sweet potato land.

Connecticut forests offer another opportunity for research and development. More than 60 percent of the land area is covered by forest trees whose value could be greatly increased by proper silvicultural practice. Farmers cannot afford to adopt effective practices until new outlets are found for their products. Much of the material now available is of post

and cordwood grade. For 10 years the Station has coöperated with the State Highway Department in working out methods of making native wood durable for posts, railroad ties and similar outdoor purposes. Results have been published and field day demonstrations of methods have attracted wide interest.

Now a more ambitious program is planned in coöperation with the State Forester, the Connecticut Forest and Park Association and other agencies. In general the aims are:

To lower production costs so that fuel wood may compete with other products such as coal, coke, or oil, (a) by more efficient methods of handling and (b) by converting the wood into other forms such as charcoal.

To increase the efficiency of wood by using slow burning stoves and automatic stokers, and by preserving wood to make it last longer.

To create new markets and new uses for wood.

Emergencies in 1939

Emergencies during the year challenge the Station's efforts in fields of research and control. The Japanese beetle continues to increase and has now been found in 80 towns in the State. While every effort has been made to supply information on protection of turf and of foliage through the use of lead arsenate, the Station looks to biological methods for eventual control.

Parasites of the Japanese beetle have been released in heavily infested sections of the State and this work will continue in coöperation with the United States Department of Agriculture. As soon as greenhouse and laboratory space is available, the research on parasites can be expanded. Meanwhile the Station will try a bacterial parasite that has given promising results in New Jersey. This so-called milky disease attacks the larvae in the soil and multiplies enormously in the body of the insect. The method is to inoculate grubs artificially in the laboratory, allow the spores to increase, grind up the bodies, mix with sand and treat infested soil with this dust.

The great outbreak and spread of gypsy moth reported last year indicate that new methods of control should be sought, and this is well started. Dutch elm disease spreads despite the efforts to remove all infected trees. Research in Connecticut so far has been confined to the elm bark beetle, carrier of the disease but other plans are under way. Less widespread, but menacing and demanding investigation, are such diseases as the red stele of strawberry that has recently appeared in our fields, and a new squash disease named foot rot.

Staff Notes

Despite losses on our staff, the Station enters the new decade with a strong personnel. Dr. W. E. Britton, Station and State Entomologist since 1901, died on February 15, 1939. Following this section is a tribute of the staff to a fellow scientist who represented the highest ideals of his profession.

Fortunately it was not necessary to look far afield for a man to undertake the leadership of the Entomology Department. Dr. Roger B. Friend

had been trained in entomology under Dr. Britton and was appointed Station and State Entomologist in May, 1939.

A second appointment in entomology was that of Dr. Raimon Beard on July 1, noted in the review of the work of the Entomology Department later in this report.

After a thorough consideration of Connecticut's needs, and search for possible candidates to fill the place, the Station Board selected Dr. J. G. Horsfall for the position of Head of the Department of Plant Pathology and Botany at the Station. Dr. Horsfall received his graduate training in plant pathology at Cornell University. He took up his duties at New Haven on July 1.

Dr. O. E. Street, physiologist at the Tobacco Substation, resigned to become head of the Federal Tobacco Station at Lancaster, Pennsylvania. Dr. Stuart LeCompte from Johns Hopkins has been chosen to fill the post.

A singular scientific honor came to Dr. Donald F. Jones who was elected to membership in the National Academy of Sciences in April.

New Buildings

A start has been made on the long delayed extension to our service building. This addition will provide small rooms for research on parasites, and two for plant breeding. Some rooms will have controls for light, temperature and humidity, all absolutely essential for this work. The building will also provide a garage and an assembly hall.

The General Assembly also made an appropriation for a greenhouse of three sections. This will provide facilities long needed for research in Plant Pathology, Entomology and Plant Breeding. Greenhouse space doubles our effectiveness in many kinds of research. For instance, two generations of plants per year can be grown, permitting experimental work on crops both in winter and summer.

A new laboratory at Windsor is also under construction. This and the building at New Haven are W.P.A. projects. At Windsor the plans call for an attractive brick structure of colonial design, with excellent facilities for research on tobacco. It replaces the old wooden building that has long been quite inadequate.

Field Days

Two field days were held at the farm at Mount Carmel in 1939. One came in June when strawberry growers were invited to see the new Station-developed berries, *Shelton* and *Hebron*, as well as outstanding introductions from other states, growing in the field at Mount Carmel.

Some 600 persons visited the farm on Field Day, August 16. Dr. Henry G. Knight, Chief of the Bureau of Agricultural Chemistry and Engineering, Washington, gave the principal address at the noon meeting in the tent. Tributes were paid the late Dr. Clinton by Mr. David A. Clarke, of Milford; and to Dr. Britton by Mr. F. S. Baker, of Cheshire.

Publications

Besides 28 bulletins and circulars published by the Station between July, 1938, and July, 1939, the staff contributed many scientific articles to journals and magazines. These, together with Station projects active in 1939-40, are listed at the back of the Report.

WILTON EVERETT BRITTON

1868–1939

Doctor Wilton Everett Britton died on the fifteenth of February, 1939. For almost forty-five years he served the Station, the agriculture of the State, and entomological science with unstinted devotion and marked ability.

He was brought up on a New England farm and from this "institution of learning" he acquired a background that enabled him later to fix the aim and purpose of his scientific work. He knew the language of the farmer as well as that of the scientist.

Graduating from what is now the University of New Hampshire in 1893, he joined the staff of this Station on May 1, 1894, his appointment being made while he was doing graduate work at Cornell. Without interrupting his Station work, he continued his graduate study at Yale and received there the degree of Doctor of Philosophy in 1903.

Doctor Britton enjoyed contacts with men and with organizations. He came to the Station at a time when the story of its work was still largely told by its staff members in person from the platform of the Farmers' Institute, the Grange and other agricultural groups. He missed no opportunity to carry the Station's message to those interests that it aimed to serve.

While engaged in investigations in horticulture he became interested in insect life and in methods for the control of their ravages on vegetation. His "Insect Notes" that appear in Station reports in the late Nineties mark the beginning of a Station activity in which he pioneered and which was to become a feature of the Station's service to agriculture. All of his many activities cannot be recounted here, but his contributions as Superintendent of the State Geological and Natural History Survey, as State Entomologist and his papers and reports as Entomologist of this Station cover all phases of entomological work in Connecticut. But his interest and influence extended beyond the boundaries of the State. He was a member of the American Association of Economic Entomologists and its president in 1909; and he held active or honorary memberships in many other scientific and agricultural organizations. In recognition of his contributions to science, the University of New Hampshire conferred upon him the honorary degree of Doctor of Science in 1930; and in the same year the University of Connecticut awarded him "Honorary Recognition" for "eminent service to agriculture and rural life".

Professional interests were not the full measure of his mental and spiritual stature. He was a public spirited citizen and served his community in worthwhile capacities. He was twice president of the Edgewood Civic Association; he organized the Donald G. Mitchell Library and served it as a director and president; he was a director of the Young Men's Institute Library, and for seven years a director of the New Haven Public Library. During the world war he was a member of the Governor's Foot Guard, 2nd Company; and chairman of the Committee on Food of the New Haven War Bureau.

A friendly, home-loving man, always dignified and unhurried, he sought the substantial values in life and leavened his seriousness with a kindly humor. As dependable as the hills that surrounded his boyhood home, he blended the pursuits of the scholar with the duties of civic service to his community. The proud traditions of this Station are built on careers like his. He commanded our respect and our affection. We are better for having come within the influence of his life.

March 8, 1939.

For the Staff

AGRICULTURAL EXPERIMENT STATION

New Haven, Connecticut

Progress of the Station's Work

ANALYTICAL CHEMISTRY

The regular duties of the Department of Analytical Chemistry are the inspection of fertilizers, of feeding stuffs, foods and drugs and insecticides. For the latter three, the Dairy and Food Commissioner enforces the acts and the Station makes the analyses. In addition a large number of analyses are made for other State agencies such as the Purchasing Department, the Commissioner of Domestic Animals, and the Storrs Station.

The staff also collaborates with the Association of Official Agricultural Chemists in studies of chemical and biological methods of analyses and in revision of the Association's book, *Methods of Analysis*.

Fertilizers

The analysis of fertilizers sold in Connecticut is an important function of the Station and has served a two-fold purpose in the State. Reports of results are in the hands of growers before Christmas, in time to help them make up spring orders. Secondly, frauds in commercial fertilizers have largely disappeared. When the work began in 1875, the buyer had no way of telling whether he was paying for the product advertised or for a poor substitute. Today a label stating the plant food contents marks every bag.

In 1939 the Station Agent visited 63 towns and villages in Connecticut and collected samples of every brand of fertilizer, registered in the State, that could be found. These amounted to 381 official samples, and were analyzed along with 443 others submitted by different agencies during the past year.

Foods and Drugs

Connecticut's interest in pure foods dates back to the days of the wooden nutmeg and grossly adulterated products. Although no claim is made that the State led the march toward regulating purity of foods, examination of products began at the Experiment Station almost as early as it was founded. Analyses of larger numbers of samples and state regulation followed both here and in other states, and the work usually fell to chemists in the experiment stations. In Connecticut, the inspection is carried on jointly with the Dairy and Food Commissioner.

In the last report, Bulletin 426, less than 4 percent of the 1240 food samples tested were below standard, questionable or adulterated. Of these, oils and frankfurt sausage made up the bulk of foods not passed, and adulterants used were in no case harmful.

The regular yearly inspection of fruit for lead or arsenate residue of spraying operations was continued. During the seven years in which the Station has examined fruits submitted by growers and by the Dairy and Food Commissioner, there has been practically no cause for alarm. Connecticut's rainfall is usually so heavy between the final spray and harvest that all residue in excess of the amount tolerated by the Federal Government is washed away. However, the Station continues the inspection which is a protection to the consumer and a service to the grower.

Biological tests of vitamin D milk have been made systematically since 1935. In the past year, of 87 samples tested, only five failed to satisfy the standard of vitamin D potency claimed for them. During the five-year period inclusive, 241 samples have been examined and 91 percent have substantially met or exceeded the vitamin potency claimed.

Feeding Stuffs

Approximately 1640 samples of feeding stuffs and related materials were examined in 1939. Again there has been a marked improvement in brands since registration was first required in 1925. The proportion of samples found substantially to meet guaranties in all respects ranged from 78 percent in 1928 to 93 percent in 1937; and the proportion of individual guaranties substantially met has ranged from 92 percent in 1928 to 97 percent in 1937.

The report on this phase of inspection includes biological tests on samples of vitamin D carriers representing 18 brands registered by 13 firms. Cod liver oil and other vitamin D carriers are commonly used in poultry feeds and other commercial feeds. They are required to be registered with the Station and to be sold under labels that show the vitamin D unitage of the article. The method of assay adopted by the Association of Official Agricultural Chemists is employed. In the past year 85 percent of the samples examined substantially met or exceeded the standard of potency claimed.

Insecticides

Insecticides and fungicides offered for sale in this State are subject to inspection and analysis to detect adulteration or misbranding, under provision of an act of legislature passed in 1923. Products of this class are examined each year and reports published at intervals. Circular 136, issued in 1939, contains analyses of 62 samples of various materials examined since 1937.

BIOCHEMISTRY

In order to obtain an understanding of the various chemical changes that take place in the tissues of plants during growth, it is necessary to be able to grow plants under strictly controlled conditions so that, at a given age or period of development, the chemical composition shall be always the same. This is, of course, an ideal that we can only approach more or less closely, but its importance can scarcely be over-emphasized. The method used involves growing individual plants in sand, supplied with chemically pure salts in the form of a dilute solution that is allowed to drip continuously into the sand. An excess over the needs of the plant is provided so that the composition of the culture solution, especially as it affects the acidity of the fluid that bathes the roots, shall change as little as possible before the solution runs out of the bottom of the containers. Strict control can in this way be exercised over what is supplied through the roots and a large measure of reproducibility is thereby obtained with respect to the rate of growth and to the development and composition of the organism.

In order to obtain more nearly ideal results, it would be necessary to control the temperature and humidity of the air, and the amount and quality of the illumination to which the plant is exposed. Facilities for doing this are not yet available.

Tobacco Leaf Studies

Tobacco plants have been grown under otherwise constant conditions but with various proportions of the nitrate in the culture solution, applied to the different lots of plants, being replaced with an equivalent of ammonium ion. The organic acid composition of this species is greatly modified as the ratio of ammonia to nitrate is increased, there being much less total acid and a higher relative proportion of unknown acids in plants that have received most of their nitrogen as ammonia. Furthermore, although the proportion of ammonia actually present in the tissues may be increased enormously in such plants, approaching in fact the levels normally found in rhubarb leaves, there is little effect upon the proportion of amides present. This observation has led to a far clearer concept of the mechanism of amide synthesis in plants than any we have previously reached. It now seems certain that the formation of the amides asparagine and glutamine is a function of respiration, and that whether or not either or both of these substances shall be formed in a given species is a matter of the nature of the organic material that is oxidized to liberate the energy required by the plant, and the manner of the oxidation. Provided that some ammonia is present, the actual level of ammonia attained in the tissues is of relatively minor importance. This view is a complete change from the explanation currently accepted by many plant physiologists, that amide formation represents an effort on the part of the plant to maintain the ammonia at a low "non-toxic" level. It represents a return to views expressed, although vaguely and with insufficient evidence, by the French physiologist Boussingault as long ago as 1864.

Rhubarb Leaf Studies

The publication of Bulletin 424 has brought to a close an investigation of the metabolism of a typical "acid plant". This study was undertaken in order to obtain data that would enable us to compare the metabolism of such an organism with a typical "neutral plant", tobacco. It has been asserted that the nitrogen metabolism differs widely in these two types of organism. On the contrary, we have found that the general behavior of the nitrogenous components during culture of the leaves is closely analogous in spite of enormous differences in the relative proportions of ammonia. The rhubarb leaf possesses an amide metabolism that differs only in detail from that of the tobacco leaf, and these studies have been of the greatest assistance in enabling us to formulate the general theory of amide metabolism already mentioned. Furthermore, the opportunity to study the behavior of the carbon in these leaves has shed much light on the nature of the substances respired. In particular, a demonstration was secured that the proteins of the leaf bear an interesting and important part in the respiration, and respiration is now recognized as a phenomenon in which a wide assortment of tissue components may share. It is definitely not merely a matter of carbohydrate oxidation as has been widely held.

Journal papers that deal specifically with the changes in the carbon and with the behavior of the organic acids in rhubarb leaves have been published.

Beet Studies

The methods of culture already mentioned have been used, in a coöperative investigation with the Department of Genetics, in a study of the effects of the composition of the culture solution on the pigmentation in pure strains of beets. Material has been thus accumulated that is expected to yield important information not only on the genetic relationships of the pigment but also on the carbohydrate and amide metabolism of this plant.

Other Plants

As opportunity has offered, several other species have been cultured under controlled conditions and prepared for chemical investigation. Bryophyllum plants—another typical "acid plant"—have been grown and the leaves subjected to water culture by our customary technic. Narcissus bulbs have been grown for the purpose of studying the effect on the composition of the form of nitrogen supplied and also to investigate the loss of nitrogen from this plant that has been reported in the literature. An investigation of the organic acids of buckwheat and the relationship of these substances to the changes in acidity of the plant at different times of day has been published. It has been shown that these changes, although small, are extremely complex and cannot be accounted for merely by alterations in the organic acid composition.

Isotopic Nitrogen Studies

A small supply of ammonium salt that contained more than 1 percent of nitrogen of atomic weight 15 has been made available to us by Professor Rudolf Schoenheimer of Columbia. This was administered to buckwheat and tobacco plants for a short period of time, and the tissue components were then separated and subjected to analysis with the mass spectrograph by Professor Schoenheimer and his associates. Evidence has already been obtained of a degree of reactivity of the leaf protein in the general nitrogen metabolism that considerably surpasses the reactivity already observed in animal tissues in the Columbia laboratory. This investigation promises to shed much light upon a number of fundamental problems and to lead to a clearer understanding of the chemical phenomena involved.

Protein Studies

A new method to determine the important basic amino acid arginine has been developed and applied to a wide assortment of proteins. The data secured are believed to be far more trustworthy than any hitherto published, and are of significance in the investigation of the problem of protein constitution. The results were briefly presented at a *Symposium on Protein Analysis* in Boston.

A general review of the problem of protein metabolism in green leaves was presented as a part of a *Symposium on Protein Chemistry* at Cold Spring Harbor.

Nutrition Studies

The studies on reproduction and on long-time growth that were mentioned last year have been continued. For some reason that is not yet clear, the attempts to produce and rear young rats on diets of purified foods have not been as successful as similar experiments that were conducted several years ago. At present an effort is being made to rule out factors that may have an adverse effect on reproduction in order that the comparison of salt mixture 351 with Osborne and Mendel salts as a source of inorganic material for reproduction may be completed.

The general problem of calcium metabolism is being subjected to a critical study to determine the best method to measure the utilization of calcium from various food mixtures. In this laboratory it has been customary to estimate the efficiency of an inorganic salt mixture by the amount of ash in the dry, fat-free bones, and in a measure this has been considered an index of calcium utilization. The method is satisfactory for animals that grow at the same rate, but may be somewhat misleading when there is a wide variation in the rate of growth. This has been particularly true in the recent investigations of the utilization of calcium from green leaves, in which variations in rate of growth have made interpretations difficult. The general problem of the utilization of calcium from green leaves is also being studied by the use of mixtures of purified foods, in order to vary the proportions of some of the characteristic constituents of the leaves in question.

In connection with the routine assays for vitamin D in milk, experiments are being conducted to determine the extent to which the healing of rachitic bones may be brought about without the aid of vitamin D. This work was suggested by reports in the literature of rapid and extensive healing of bones by the addition to the food of salts of citric acid and of other organic acids. Partial confirmation has been obtained.

ENTOMOLOGY

The Entomology Department suffered a great loss in 1939 when Dr. W. E. Britton, Station Entomologist since 1901, died on February 15. As noted in the introduction to this Report, Dr. Britton had served the Station since 1894. The story of his life since 1901 is really the history of the growth and development of entomology in Connecticut. A biographical sketch, written by his successor, will be found in the Report of the State Entomologist, Bulletin 434.

The Station was fortunate in having in the Department a man trained under Dr. Britton and capable of carrying on his work. On July 1, 1939, the Board of Control appointed Dr. Roger B. Friend Station and therefore, State, Entomologist. Dr. Friend came to New Haven in 1924 after graduation from Massachusetts State College. He entered the Graduate School at Yale University, serving the Station part time during his four-year term there. After receiving the degree of Doctor of Philosophy, Dr. Friend was given an appointment on the Yale faculty and also on the Station staff. Chief among his interests in the field of entomology has been the study of insect pests of forest trees.

A second appointment in the Department is destined to further the work with vegetable pests. Dr. Raimon Beard received his doctor's degree at Yale in 1939, four years after graduation from Wesleyan University. For the past five summers he had been employed at the Station. His thesis for a degree was a study of the squash bug, a serious pest of the crop in Connecticut.

The work of the Department as it was created by the State Statute, is divided between investigation or research on insect pests of plants, and control or service. Some projects, such as the suppression of the Japanese beetle, include both of these fields.

The Japanese Beetle in Connecticut

Eighty towns in Connecticut are now known to be infested by the Japanese beetle. The pest has increased to such proportions that it was observed feeding on many kinds of trees as well as vines, ornamentals and flowers in the past season. At a conservative estimate the grubs have destroyed or damaged upward of 2,000 acres of turf, golf greens and lawns, and thousands of pounds of lead arsenate have been used in control efforts.

Control measures, observations and research are joint efforts of the Station and the U. S. Department of Agriculture. Plants and other materials included under federal quarantine are examined and certified for shipment outside the quarantine area, or for classified dealers within this area. In the past year, 35,969 federal certificates were issued.

In the field-spray tests for protecting plants against the beetle, lead arsenate with a good sticking agent surpassed other materials used. Derris with rosin residue emulsion leaves very little visible residue but must be applied weekly for effective protection. The mixture of tetramethyl thiuram disulfide and rosin residue emulsion was promising but this spray was expensive.

Biological control of the Japanese beetle is also part of the Station program. Seventy-five colonies of three species of parasites have been released in Connecticut. Preliminary work has also been started for testing the use of the milky disease, a bacterial parasite that has given worth while results in New Jersey. Expansion of experimental work with parasites is planned when laboratory space is provided in the building now being erected on Huntington Street.

Elimination of the Mosquito Nuisance

Two events that have bearing on the mosquito elimination program in Connecticut occurred during the past year.

A disease of horses, *Equine encephalomyelitis*, and transmittable to humans as encephalitis, has been present in California, Minnesota and Massachusetts. Laboratory experiments in these regions proved that the disease is carried by several species of mosquitoes common in Connecticut.

At its final session in 1939, the General Assembly created a new commission to supervise and coördinate mosquito control work in the State. The Director of this Station is a member of the Board and the office of the deputy will be maintained at the Station for the present.

Until the Board started to function, however, the work was continued under this Department. It followed two lines: maintenance of salt marsh areas that had been ditched and technical advice on projects in which mosquito problems occur.

All of the salt marsh area of Connecticut has been ditched and about half of this, amounting to 11,000 acres, has been accepted for State maintenance. A small force of men patrolled the accepted area from April 10 until September 15, cleaning out ditches and conditioning them to keep the water running freely. No additional areas can be accepted until the State supplies additional funds.

Federal funds through the WPA have made possible continued improvements of salt marsh drainage outlets. Some of the projects, more especially fresh water swamp drainage, are sponsored by the towns, and salt marsh work by Station and towns.

The Biology and Control of Termites

The usual large number of requests for inspection of buildings, thought to be infested by termites, came to the Station in 1939. This year it was possible to answer most of the calls with copies of Bulletin 382, *Termite Control in Buildings in Connecticut.* In addition, actual examination was made of 61 buildings: 51 were infested with termites, 8 with other insects, and in 2 no damage was found.

Investigations have led to the belief that proper construction is the only certain permanent method of keeping termites out of buildings. However, two experimental soil treatments were made to test arsenical compounds as a measure of control. In one case the soil beneath a concrete garage floor was treated along the infested walls. A .5 percent solution of sodium arsenite was used in April, 1938. No termites have appeared since. Applications of arsenate of lead to stop building of shelter tubes up the concrete wall of a house failed within six months.

A brief and practical account of the methods used in actual control operations was published as Circular 134 in May, 1939.

Pests of Vegetable Crops

European Corn Borer

So serious is the injury of the European corn borer to early sweet corn in Connecticut, ripening between July 10 and 25, that it is usually unprofitable to raise the crop in the southern counties of the State. Treatments with sprays and dusts developed by the U.S.D.A. and tried at different time intervals and rates of application have produced profitable crops of borer-free ears at the experimental farm. Growers using the materials have not had the same success, probably because they have not yet mastered the technique. Although the treatments do not give complete control, it is believed that farmers cannot afford to raise early sweet corn without this protection.

During the past season heavily infested fields were dusted with dual-fixed nicotine at intervals of three, four, five, six and seven days from June 7 until June 25. There was little difference among yields of No. 1

borer-free ears with the several treatments, except that the seven-day was somewhat less effective. Approximately 50 percent of good ears were taken from the other plots, while the check gave only 13 percent.

Other tests at varying intervals were unsatisfactory. Hand application of dust proved better than machine applications.

On late sweet corn there was little difference in control of the corn borer in fields dusted at five- and seven-day intervals during August. Modifications of this schedule were significantly less successful.

Machine dusting with two nozzles to the row gave 50 percent marketable ears compared with 56 percent for hand-dusted corn in another test. Four dusts used on a less heavily infested field were far superior to two and three dusts on one that was heavily infested in August.

Although the burning or clean plowing under of corn stalks, stubble and ears is still advocated as a means of curtailing the population increase of the European corn borer, the Station did not enforce the compulsory clean-up in 1939. The enforcement of such a state law is a police duty and not a function of the Station. However, the proper disposal of corn debris before April 25 of any year is still on the books and growers are expected to comply with the law for their own protection.

The Corn Ear Worm

Late in the season corn ear worms appeared in at least two fields of sweet corn in the New Haven area. The first of these was about 75 percent infested by ear worms, and also had a heavy infestation of corn borers. It was a total loss. The second was about 25 percent infested by ear worms.

ON POTATOES

The European Corn Borer

Apparently the yield of potatoes is not normally affected by infestations of the European corn borer. Two rows of Irish cobbler potatoes were grown under uniform cultural conditions at the farm in 1939. In one row all plants were kept free from corn borer eggs and in the other all plants were artificially infested with corn borers. When the potatoes were dug, there was no significant difference in yield between the two rows. Yields of this kind of potatoes satisfactory to the grower have been obtained in some fields where corn borers were common.

Wireworms

In October, 1939, a preliminary survey of wireworm injury was made in 17 fields of potatoes, chiefly in Tolland County. In each place the extent of damage was estimated, soil samples were taken and, as far as possible, the history of the field was recorded. The number of potato tubers showing some evidence of wireworm feeding ranged from 2.3 to 66.6 percent, with an average of 23 percent. These figures are larger than the actual amount of cull due to wireworms, for many of the feeding punctures recorded were too superficial to be graded out as grading is usually practiced. The least injury noted occurred in East Windsor in fields which had been in tobacco for many years before 1939. No

correlation could be observed between the extent of injury and the physical and chemical nature of the soil.

ON SQUASH

The Squash Bug

Insect pests of the squash crop are a constant threat to profits in Connecticut and investigations for their control have been carried on for a number of years at the Station. The squash bug was less abundant in 1939 than normally, probably due to climatic factors of the 1938 season. However, studies on abundance, particularly as affected by the parasite, *Trichopoda pennipes*, are being continued. Some of the results will be published as Station Bulletin 440.

Avoiding the Squash Bug and Vine Borer

During the summer experiments with summer squash at the farm at Mount Carmel definitely demonstrated that injury by both the squash bug and the squash vine borer can be largely avoided by planting tactics. Two plantings were made, the first about mid-May and the second about the first of July. The later crop began to yield fruit the second week in August, a time when the first crop was becoming less productive because of damage by insects and disease. The bulk of oviposition by both the squash bug and borer occurs before the second planting of squash is attractive to the insects. Accordingly, most of the injury occurs on the first planting which can be destroyed when the second planting comes into bearing.

Insect Pests of Forest Trees

Bark Beetles of the Elm

The study of bark beetles of elm, carriers of Dutch elm disease, is part of the Dutch elm disease control program, also reported under Forestry.

Laboratory experiments have revealed that cold alone does not markedly affect the abundance and distribution of *Scolytus multistriatus* in Connecticut. Sustained exposure to −5 degrees F. in the laboratory did not greatly influence the mortality of larvae in logs, and some exposed larvae survived rapid cooling to temperatures as low as −18 degrees F., as determined by the thermocouple method. Since such low temperatures are rare over most of the State, the above conclusions are justified.

Distribution studies show that the beetle is slowly increasing in Connecticut although it is not generally present east of the Connecticut River. Work on the life cycle is about complete and results are published in the Report of the *State Entomologist for 1939*, Bulletin 434.

A number of other practical investigations are being carried on in collaboration with such agencies as the Federal Bureau of Entomology and Plant Quarantine and the W.P.A. Among these are: the effect of trap logs on beetle abundance and on the feeding of this species around piles of such logs; the effect of pruning elms on beetle abundance; and the effect of chemicals in protecting elms against adult feeding, and logs against attack. Insecticides have been applied to living trees but no very promising results have been secured. Creosote applied to elm logs appears to protect them from attack and to kill beetles already present therein.

Biology and Control of the European Pine Shoot Moth

The European pine shoot moth is a devastating forest pest, especially in the southern counties of Connecticut. It infests the tips of red, mugho and Scotch pine, killing and deforming the growth. In the past year a new series of studies of this insect and its habits has been started in the towns of North Haven and North Guilford.

At North Haven, trees average 12 feet in height and are very heavily infested by a population that has been building up for a number of years. It appears that the saturation point has been reached and numbers are expected to decline in the future for several reasons. The number of larvae hibernating is so great that practically all the buds in the tops of the trees have been destroyed and will not grow next spring. However, the trees have formed some latent buds and shoots on which a certain percentage of larvae can feed and survive. At present the growth of this stand is seriously retarded.

The plantation at North Guilford contains trees averaging 3.5 feet in height and has been infested for approximately two years. Although the infestation was very light in 1938, it increased greatly during the past season and its progress throughout the stand is being carefully watched. All of the trees in the area have been mapped for two seasons and the infested trees have been indicated. In this way the manner of insect spread and the rapidity with which a dangerous population builds up can be partially accounted for.

In both stands, other pertinent factors will be taken into account. The effects of climate and parasites on the population will be noted. Differences between the theoretical number of eggs an adult female can lay and the number actually laid as determined by the number of bored needles per shoot will be considered. Survival counts to determine the normal larval mortality in each area are also being made.

Control of the pine shoot moth is supervised jointly by the Entomology and Forestry departments working in coöperation with the C.C.C. and the W.P.A.

The Gypsy Moth

The usual coöperative gypsy moth control work between the Station and federal agencies has continued during the 1938-1939 season. The gypsy moth office of the Bureau of Entomology and Plant Quarantine concentrated its efforts on the Barrier Zone and the region immediately east of that zone; the men employed by the Station concentrated on the eastern part of the State, and the crews from the C.C.C. were used where available.

In the extensive spraying operations in Granby, mentioned below, all three agencies combined efforts and maximum results were obtained. These agencies covered 75 towns in which 430 infestations were found; 8,260,640 egg masses were creosoted; 31 infestations were sprayed with 150,496 pounds of lead arsenate; 426,547 bands were applied and 53,151 larvae and pupae were crushed; 1,200 miles of roadside and 204,350 acres of woodland were scouted; 684 acres of woodland were cleaned.

At the Granby infestation mentioned in last year's report, 1,521 acres of woodland were sprayed during May and June with more than 20 tons of lead arsenate. This is the largest continuous block of woodland ever sprayed in this State. Five spraying machines, with the crews working two 6-hour shifts daily, were used, increasing by 50 percent the amount of spraying accomplished. A water shortage caused by the drought, handicapped the work to some extent; only three of the five machines could be used part of the time. The infestation in 1939 extended beyond that of 1938.

Two other infestations deserve mention. That in Union, which covered about 100 acres in 1938, is greatly reduced this year. A newly discovered outbreak in Southbury involved several acres, but only about one acre was completely defoliated. This latter infestation is in the Barrier Zone and will be cared for by the federal agencies.

Insect Pests of Fruits

The Oriental Fruit Moth. Parasites

The peach industry in Connecticut is vitally affected by the abundance of Oriental fruit moth in any one year. Both artificial and biological control experiments have been a part of the Station program for the past decade. The Pomological Society of Connecticut has coöperated in the parasite work, making the original donation to start it, and now distributing parasites among subscribing members. The money received is contributed to Station expense of breeding.

The population of moths was low in 1939 so that the results of spray and dust experiments were negative.

Besides the rearing and distribution of parasites, a systematic check of conditions in a number of commercial orchards was undertaken. The object is to find, if possible, what influences the degree of parasitism and how this is related to the moth population. All factors bearing on the fruit infestation are being considered and much data has already been collected. The Station has published a 10-year summary of the parasite situation as Circular 140.

In the field of rearing and distribution, the following parasites were sent to growers: *Macrocentrus ancylivorus*, 16,134; *Bassus diversus*, 1,012; and *Dioctes molestae*, 1,775. A total of six million Trichogramma were also sent out.

Recovery attempts of the various species indicate that *Bassus diversus* has survived at least three years in some localities, though so far it has not become abundant enough to be of much benefit. *Dioctes molestae* was recovered in 14 different orchards, but our observations so far indicate that it does not live over the second year. Whether this will hold true in the future, whether the parasite can accustom itself to our climate, remains to be seen. *Macrocentrus ancylivorus* recoveries reached a high figure in 1939. This, we believe, together with the somewhat unfavorable season for the fruit moth, helped reduce the infestation considerably from the 1938 level.

The European Red Mite. Predators

The results of studies of the European red mite, a serious pest of fruit in Connecticut, have been published as Station Bulletin 418. Enemies of the red mite are an important control, and it was found that their number is depleted by the use of sulfur in the spray treatment. Observations are being continued and work with sprays that promise reduced kill of valuable predators is being carried on. The project depends in part on development of a satisfactory fungicide omitting sulfur.

Biology and Control of the White Apple Leafhopper

The white apple leafhopper is another injurious pest of Connecticut orchards. Circular 111 was published reporting studies to 1936. In the past year work with this insect has been confined to observations in commercial orchards and a few small-scale tests with rotenone sprays. No extensive spray experiments were planned, because the general population of leafhoppers was rather small. Observations in a block of interplanted Northern Spy and McIntosh indicated that a population of slightly less than two per leaf in late August, even where the foliage was very dense, did not produce serious spotting of the fruit.

Substitutes for Lead Arsenate in Orchards. The Apple Maggot

As in previous years, work with substitutes for lead arsenate on fruit has centered around control of the apple maggot. A dust prepared by a commercial concern and consisting of .5 percent rotenone, 4 percent white lubricating oil and pyrophyllite carrier gave satisfactory control in an orchard seriously and heavily infested for the two preceding seasons. Four applications were made during July.

Adhesives for Standard Spray Mixtures. Curculio

This year, various drying and semi-drying oils were compared with fish oil as stickers for the special curculio spray. Analyses were made by the Chemistry Department. Equally good results were indicated with soy bean, fish oil and perilla oil, and approximately the same with aluminum sulfate. A commercial spreader and sticker showed no advantage over the checks which were sprayed with lime and lead arsenate only.

Considerable work was also done with "dynamite" sprays in comparison with the lime, lead arsenate and oil. Analyses indicated a much heavier deposit with "dynamite" sprays and better insect control at the end of the season. It has been found possible in dry seasons such as 1939, to stop spraying with arsenicals the middle of June and still obtain reasonably clean fruit at harvest.

Investigation of Oil Sprays

Studies of the effect of oil sprays containing di-nitro-cyclo-hexyl-phenol were continued in 1939 with extensive observations in commercial plantations where these materials have been employed. In general, our conclusions indicate that good control of rosy and green aphis may be had with these materials, but control of the European red mite does not seem quite as good as with the best lubricating oil sprays.

Rodent Control in Orchards

The U. S. Bureau of Biological Survey has coöperated with the Connecticut Agricultural Experiment Station during the past year on a part-time basis. Research studies on ecology and control of the pine mouse (*Pitymys pinetorum*) were the main objective. Detailed studies were conducted to determine the more adequate means of control and the rate of reinfestation or drift of the mice. Supplementary data were also collected on the food and breeding habits of the mice. These projects will be continued throughout the coming year.

Insect Pests of Tobacco

This Department supervises the work on insect pests of tobacco carried on at the Tobacco Substation at Windsor. A brief account is given under the Substation section. More detail will be found in the annual report of the Tobacco Substation, Bulletin 433.

Pests of Lawns and Grasslands

Scarabaeid Larvae

Increase in the scarabaeid larvae in Connecticut lawns has led to investigations of the various species: *Popillia japonica*, *Anomala orientalis*, *Autoserica castanea* and *Cyclocephala borealis*. This Department is coöperating with the Soils Department in studying the immediate and residual effects of using various fertilizers on turf treated with lead arsenate. The life history and control of *Cyclocephala borealis*, an annual white grub that injures turf, has been worked out and a journal paper on the subject is in preparation.

Chinch Bug

In 1939 we started experiments on the control of the eastern chinch bug, a pest of lawns. Tobacco and rotenone dusts are being tested as insecticides and populations of chinch bug injurious to lawns determined.

Insect Survey of Connecticut

The Station collections now contain about 7,200 species of insects, almost all from Connecticut, and a large number of Connecticut spiders. One of the most important additions during the last year was a collection of 264 slides of Connecticut mites and 200 slides of Connecticut Collembola, given to the Station by Mrs. Arthur Paul Jacot. These were collected and mounted by the late Dr. Jacot.

The work on the Diptera, or true flies, of Connecticut is progressing and a manuscript of the first fascicle has been submitted to the State Geological and Natural History Survey for publication. The manuscripts for several other fascicles are practically complete.

In order to care properly for our expanding collection, five cases, each containing 12 glass-topped drawers, were purchased. These cases are the Cornell type, probably the most efficient made for the purpose.

Inspection of Nurseries, Apiaries and Imported Stock

Nursery Inspection

During the summer, 399 Connecticut nurseries with an area of 4,833 acres were inspected in compliance with Section 2136 of the General Statutes. Some of these were inspected twice to check on the eradication of pests. Altogether 96 different insect pests and 52 plant diseases were found but most of them were of little importance.

In addition, members of the Department visited 240 orchards, farms and gardens and made the regular inspections of plants and nursery stock imported from foreign countries.

Apiary Inspection

In 1939 the two apiary inspectors visited 156 of the 169 towns of Connecticut and inspected 1,633 apiaries, containing 8,975 colonies. They found 145 colonies in 81 apiaries infected with American foul brood. Of the infected colonies, 21 were treated and 124 destroyed. The average number of colonies per apiary was 5.496, and the average cost of inspection was $1.118 per apiary, and $.203 per colony.

Mr. W. H. Kelsey, inspector for the four northern counties of Litchfield, Hartford, Tolland and Windham, reported heavy winter loss.

Only two colonies of sacbrood were found in the entire State.

FORESTRY

THE PROGRAM of this Department was seriously upset by the hurricane of September, 1938. Immediately there rose the time-consuming problem of salvaging usable material at Rainbow Forest, complicated by the fact that much of the down timber was of a size not readily marketable. The Rainbow Guide and Progress Report, which was almost ready for publication at the time of the hurricane, had to be completely revised because of changed conditions. The Shaker Pine experiments were terminated, as the entire stand was felled by the storm. The Blister Rust Control program had to be revised after a survey of the remaining white pine in the eastern part of the State. Studies of forest plantations were interrupted and plantation records must now be corrected because many of the plantations no longer exist.

New problems of forest utilization and future management of stands were created by the hurricane. Dutch elm disease control has been tremendously complicated by the presence of hurricane felled elm wood in great quantity throughout much of the control area.

The Rainbow Experimental Forest

At Rainbow the work of the past year has been of two kinds:

1. Material salvage of logs, posts and cordwood felled by the hurricane. Some 80,000 board feet of logs were sawed into timber of various dimensions. A tally of the logs was kept by plots. In addition to logs, about

500 posts and several hundred cords of wood were removed from the plantation. Brush was either burned or piled for later disposal. The work was done by WPA and CCC crews, supplemented by some hired labor.

2. Obtaining all possible information on felled and standing trees as follows:

Diameter and height measurements were taken on all plots old enough to measure and all trees were recorded as either standing or felled. This is the first time that so complete an inventory has been made. It will serve to close out the stands that were severely damaged, and as a reference point for future studies of growth on those plantations which are still intact or were only partially damaged.

Over 500 taper measurements were made on felled white pine and these, with some 400 obtained elsewhere, have been incorporated into three volume tables for the species. Bulletin 427 reports the results of this work.

Logs from seven species were sawed into about 500 timber testing samples. These will be tested during the coming winter as thesis work by students of the Yale School of Forestry, and the results will be available for publication later.

Mill studies made during the sawing of the lumber will make it possible to compare the actual yield of sawed material from the several plantations with the computed yield from a tally of the logs based on the International Log Rule.

During the coming year the new Guide, publication of which was delayed by the hurricane, will be revised and completed.

Miscellaneous incidental studies, covering insect and fungous pests as well as soil problems, were made in coöperation with the departments of Plant Pathology, Entomology, and Soils.

Studies of Forest Plantations

Some additions have been made to the forest plantation records, bringing the total number of described plantations to about 2,000, or approximately 90 percent of all those in Connecticut.

Preservative Treatment of Fence Posts and Other Wood Products

Although this project was suspended during most of the past year, recently additional experiments with the use of water soluble salts have been started. During the fall, a student of the Yale School of Forestry began a study of the quantitative distribution of zinc chloride in treated posts. The Station is providing the treated material and the student is performing the analyses. The results will be a valuable contribution in the field of wood preservation.

At the present time, the Station is coöperating with other state agencies in an effort to find outlets for low grade forest products in competition with coal, oil, steel and other materials. Attempts at solution of this problem include: reducing the costs of production of the wood itself; converting it to more useful or more salable form; treating it to increase its usefulness, and possibly finding new uses for wood.

Most of our native woods are non-durable and are worth about 75 cents per cord on the stump for fuel. If preservative treatment is used, many of these woods, post size, are worth $1.50 per cord stumpage. A good groundwork in the preservation of posts, small poles and other native grown wood products, both with creosote and with water soluble salts, has been built up by the Station over a period of 12 years. This work fits in well with the general program described above and should be expanded to keep pace with the latter.

Control of White Pine Blister Rust

Blister rust control activities during the past year included the following projects: wild ribes eradication, nursery sanitation, mapping pine areas, marking control area bounds, and an estimate of white pine blow-down in eastern Connecticut. The work was done entirely with WPA and CCC labor.

Wild ribes eradication was conducted in 22 towns on 47,978 acres of land where 570,405 wild ribes and 1,846 cultivated ribes were destroyed. Nine nursery sanitation zones were rechecked and ribes eradicated.

Pine mapping was carried on in 10 towns where 112,579 acres of pine and control areas were mapped in detail. An additional 178,918 acres were examined but not mapped because of the absence of pine.

Marking control area bounds was done for the purpose of identifying these areas readily and increasing the efficiency of eradication work. There were 134 miles of such bounds marked to outline 900-foot zones surrounding pine stands.

The hurricane of September, 1938, wrecked the older pine stands in eastern Connecticut. A survey of this area was made to determine the amount of pine damage and to gather data on which plans for future control work can be based. This survey was supervised and summarized by the blister rust organization of the U. S. Department of Agriculture. The field work was done coöperatively by the Timber Salvage Administration of the U. S. Forest Service, the State Forestry Department by means of CCC crews, and the Works Progress Administration through the Dutch Elm Disease Sanitation and Blister Rust Control projects. A total of 1,496,219 acres were examined and the percentage of blow-down timber was recorded by forest types. Rough board-foot estimates of the down white pine were also made.

Control of Dutch Elm Disease

As during the previous four years, efforts to control or eradicate Dutch elm disease have been carried on during the past year in coöperation with the U. S. Department of Agriculture, but have been greatly complicated by conditions resulting from the hurricane. In all the shore towns, many elm trees were felled by the storm and, in the following clean-up, much of this material was left on the ground or stored on private property in the form of firewood. This material provided ideal breeding places for the elm bark beetles which are the principal vectors of the disease. The condition was particularly serious in the area east of New Haven, including the towns of Branford and Guilford in which the disease was first found

in 1936. The U. S. Department of Agriculture forces made every effort to clean up the situation. Elm sanitation crews from the WPA were also utilized for the purpose, although many of these were diverted to fire hazard reduction work along the state highways. It is too early to determine whether the results have been successful in preventing an abnormal spread of the disease.

During 1939, 402 elms infected with Dutch elm disease were found and destroyed. This is a smaller number than the 535 cases of 1938. The diseased trees were found in 11 new towns, mostly in Fairfield County or directly adjoining it. Milford, West Haven and East Haven are also included but the most alarming extension of area occurred when 21 cases were found in Woodbury and one in Litchfield.

All of the new towns had been scouted previously but this was the first year that symptoms of disease were noted. The Station has continued to assist the U. S. Department of Agriculture in obtaining releases for elm tree removals. In view of unusual conditions after the hurricane, the Station employed one man during the summer of 1939 to scout for and obtain releases on beetle breeding elm material in towns east of New Haven. This was done in coöperation with the U. S. Department of Agriculture crews who disposed of the material thus released.

The WPA elm sanitation program sponsored by this Station has continued throughout 1939 but will probably be discontinued soon. There are now about 30 WPA crews at work in various towns removing dead and dying elm material. Although much good has been accomplished, it would be more satisfactory to have the work carried on by local organizations.

There are certain encouraging factors in the record for the year. It appears practical to eradicate the disease, or at least to keep it at a very low level, in isolated infection areas such as Old Lyme and Guilford where there have been no cases in 1938 or 1939. This is also true in areas where there are few woodland elms, as in metropolitan New York which has remained practically free from the disease this year. In certain sections of Greenwich, Stamford and Weston, control has apparently been attained by intensive sanitation measures. No further infections were found this year in Bridgeport, Stratford, Danbury or Newtown where intensive sanitation measures were carried on in the winter of 1938.

The number of requests for inspection of elms has increased, necessitating the sampling of more than 100 trees and the culture of many of these by the Plant Pathology Department. Other cultures have been made to verify the results of federal diagnosis in cases of first infections in new towns. The first samples from the diseased trees in Litchfield were brought in by Station men and cultured here.

After a public hearing held at the Station on October 17, 1939, the State quarantine zone was extended to coincide with the Federal quarantine area. It now includes all of Fairfield County except Brookfield, New Fairfield and Sherman, as well as the towns of Southbury in New Haven County and Woodbury in Litchfield County.

During the coming year, the work of the Station will probably be concentrated on better methods of control. The coöperation of private land-

owners in any control program is of utmost importance. The local tree warden in each town in the State should be actively and intelligently coöperating in the pruning of elms and disposal of all elm wood. This is particularly important in the known infected areas. The Station should furnish the leadership, but further research is necessary before specific control measures can be recommended. Some of this research has been carried on in coöperation with the Entomology Department.

Distribution of Forest Planting Stock

As in past years, the Station has continued to supply Connecticut landowners with forest planting stock at cost prices. The increased demand anticipated after the hurricane was not realized. The majority of orders during 1939 were as usual from the western half of the State where the effects of the hurricane were not serious. An increasing interest in the management of forest lands is evident everywhere and it is quite probable that forest planting will be stimulated in the hurricane area during the next few years.

In the spring of 1939, a total of 487,000 trees was distributed by this Station. Since 1925, a discount has been granted on stock sold to farmers, for which reimbursement has been received from the Federal Government under the Clarke-McNary Act. In 1939, 161,000 trees (33 percent of the total) were sold to farmers. About 50 percent of all trees sold were white and red pine. It has been necessary to discourage the use of red pine in recent years, particularly in the southern part of the State, on account of the prevalence of European pine shoot moth in that section. Consequently, there has been an increasing use of Douglas fir, Norway and white spruce.

As the Station receives no appropriation from the State for this project, it must necessarily be managed on a self-supporting basis. This fact precludes any great expansion requiring investment of funds which could not readily be liquidated in a year or two. On this account, the Station welcomed the recommendation made by Governor Cross's rehabilitation committee that the General Assembly provide an appropriation for the establishment, maintenance and operation by the State Forester of a nursery with a capacity of 1,000,000 transplants to supply planting stock to farmers and other woodland owners at cost. This proposal was aggressively opposed by commercial nurserymen and was unfavorably reported by the Legislative Committee to which it was referred. Since no other method seems practicable at present, the distribution of forest planting stock in Connecticut will continue to be handled by the Station.

GENETICS (PLANT BREEDING)

Hybrid Field Corn

EVERY year Connecticut farmers plant approximately 53,000 acres of field corn. This comprises crops for grain, silage and forage. Native field corn makes quick development, produces large ears and abundant green stuff, but has the unfortunate tendency to break in the wind storms of late summer. Numerous hybrids of dent corn have been made in the

Middle West and many of these were tested for Connecticut conditions at the Station farm at Mount Carmel in 1938. Some were vigorous and productive and showed remarkable ability to stand erect throughout the season. These were selected and planted again in 1939.

A study of the available inbred material has shown that many strains are well adapted to Connecticut and combinations of these, in preliminary trials in coöperation with seedsmen and farmers in the northeastern territory, are proving valuable. Due to the marked differences in the length of the growing season in different parts of the State, it is necessary to have corn that is properly adjusted in maturity both for ensilage and for grain. Freedom from fungous infection, through the use of resistant inbreds, means more vigorous root and stalk growth, and healthier plants with ears that are freer from rots and molds.

Early Sweet Corn

The introduction of *Spancross*, *Marcross* and *Carmelcross*, three Station developed sweet corn hybrids, gives market gardeners of Connecticut a series of hybrids that can be planted at one time and yield a succession of ears from very early to mid-season. Marcross has already proved itself a valuable addition to the Golden Early Market season. It is uniform in stalk growth, even in ripening and produces a large ear of good quality.

Demand for early sweet corn has led to production of Spancross (C4.13). Ripening a few days earlier than Marcross, this new hybrid has already attracted much favorable attention. Spancross has the same vigor and uniformity of production that Marcross has. The stalks are shorter in height and the ears are somewhat smaller. The plants are free from serious injury by bacterial wilt and smut, and the table quality is excellent for such an early sweet corn.

The demand for a large eared corn of good quality to follow these two early sorts has been met by the production of Carmelcross (C13.P39). It follows Marcross in maturity and produces ears as large as Whipple, uniform in size and shape, remarkably tender and sweet.

Beets

Beets vary markedly in pigment and sucrose content from season to season. The Station has been carrying on investigations of environmental factors affecting these characteristics. Among the many commercial strains and varieties grown at the Station farm in the last two years, practically every one produced twice as much, and some three times as much, pigment in 1938 as in 1939. In the greenhouse, beets have been grown in different levels of nutrient solutions to determine what influence varying amounts of fertilizer elements have on the color and sugar content, but there are no definite conclusions to be reported yet.

Squash

For the past nine years inbred lines of squash have been crossed and their progeny tested for the presence of hybrid vigor in the first generation. In 1938 and again in 1939, this expression was witnessed at the farm at Mount Carmel. Never before has it been reported in summer squash.

In 1937 a cross was made using Early Prolific Straightneck, a new introduction by Ferry Morse Seed Co., and an inbred line of our own. This cross was grown in 1938 and it was noticeably earlier and more productive than either parent.

In 1939 the same cross was grown again. The first picking on the hybrid was one week earlier than on either parent. The yield of the cross at the time of the first picking on the parental types was three times greater than that of the parents. This observation may have far-reaching effects.

It is reasonable to predict that hybrid squash seed may be produced commercially in the same manner as hybrid corn.

In squash, male flowers and female flowers develop on the same vine. Two lines of squash selected as parents may be planted side by side. Before the female flowers open, male flowers may be removed from the row which is to be the female parent of the cross. Normally bees and wind will carry the pollen from the male to the female row.

Disease Resistance in Cantaloupes and Cucumbers

Downy mildew is probably the most serious disease attacking cantaloupe and cucumber. So severe is the trouble in some years, that growers cannot depend on these two vegetables for market crops in Connecticut. Plant pathologists have long been working on spray treatments that will successfully control the disease without reducing the yield and a report on this work is included in the plant pathology section.

In 1939 the Station became interested in breeding disease-resistant cucurbits adapted to local conditions and started a program to develop such strains. Seed of strains and varieties reported to be resistant to one disease or another were collected from different parts of the country and planted at Mount Carmel. When downy mildew attacked the crops late in August, only two lines showed any appreciable resistance. One cucumber strain from Porto Rico appeared to be immune. Similarly a commercial variety of green-fleshed cantaloupe from Florida had many plants which did not succumb to this disease, but were susceptible to bacterial wilt.

Celery

Another project under way for the purpose of breeding resistant lines is in celery. The Eastern States Farmers' Exchange made a cross between a wild European type and commercial lines and grew a first generation hybrid that showed some resistance to blight. The Station has planted second and third generations of this cross at the experimental farm at Windsor, each season making selections for early and blight-resistant plants.

Strawberries

From a long list of new hybrid strawberries that have now been tested for seven years, two selections have been named and are offered to Connecticut strawberry growers. These are *Shelton* and *Hebron*. They resulted from an investigation of the effects of inbreeding and crossing vegetatively

propagated fruits. Shelton has many of the fruit characteristics of Chesapeake combined with some of the plant growth and productiveness of Howard Premier. It has unusual ability to retain a bright attractive color in the fruit after picking. Hebron is a late maturing variety that is productive and unusually attractive in color of fruit. Both are adapted to Connecticut and have shown promise in trials in different parts of the State.

Principles of Genetics

Further knowledge of the mechanism of cell division and chromosome behavior is being sought in a study of abnormal endosperm development and in color mosaics in corn kernels. In coöperation with Dr. L. J. Stadler of the University of Missouri and the U. S. Department of Agriculture, the effect of ultra-violet light upon chromosomes is being studied. An attempt is being made to accumulate favorable growth factors in corn by a process of selection in backcrossed lines. This work promises better inbreds for use in hybrid combinations.

PLANT PATHOLOGY AND BOTANY

The appointment of Dr. James G. Horsfall as Chief of the Department took effect July 1, 1939. Dr. Horsfall came to Connecticut from the New York Station at Geneva where he made a splendid record through his researches on plant diseases, especially those of vegetables, and of fungicides.

Since Dr. Clinton's retirement in 1937, and pending Dr. Horsfall's appointment, Mr. Stoddard had been Acting Chief. He will now be able to give full attention to fruit diseases, his particular responsibility.

Assisting Dr. Horsfall in his investigations of fungicides are two Fellows assigned to the Station by the Crop Protection Institute. Also the program on vegetable diseases is being reorganized and several new investigations planned for 1940.

Downy Mildew on Muskmelons and Cucumbers

Many years ago, in fact as early as 1890, mildew was destructive to muskmelons and cucumbers in Connecticut. Doctor Clinton published an extensive account of its depredations in the State in 1904. Frequently, since then, it has been an injurious pest, and was serious in 1937, 1938, and 1939, especially on the late crop.

Attempts to control downy mildew with sprays of Bordeaux mixture have been conducted for years in many states. Results have been disappointing, not so much because the disease was not held in check, as because the yields obtained did not pay for the spraying. Recently it has been found that tomato plants showing much of this same reaction had been injured by the Bordeaux and that the injury was traceable to the lime in the mixture. As a result, new lime-free sprays have been developed that give promise of solving the downy mildew problem economically.

Several of these were tried in 1939. Disease control was somewhat lower with the new copper compounds than with Bordeaux, but the yield was above that obtained with Bordeaux. Since farmers consider yield more important than elimination of the last sick leaf, they have become interested in the new materials and several used them during 1939.

Experimental work is to be continued.

Defoliation Diseases of Tomatoes

Most weather prophets are inclined to agree that the weather cycle indicates generally moister seasons for the early nineteen forties than during the early and middle nineteen thirties. If so, we can expect a continuation of the defoliation diseases of tomatoes.

These diseases that kill the leaves carry in their wake troubles with the fruit, such as poor color, increased cracking, sunscald, and anthracnose. Farmers sell fruit. Quality fruit sells best and frequently the very late crop commands a better price than the mid-season crop. Accordingly, the farmers realize that they must keep the tomato leaves intact if they are to sell their produce at the highest price. Foliage diseases are most difficult to combat late in the season.

The Station fortunately is forearmed on this advancing problem. New materials and new practices are now available to help avoid the ravages of tomato leaf blights.

The new materials contain none of the lime that was found to be detrimental in Bordeaux. They control disease without reducing yield. Perhaps the two most promising new materials are yellow copper oxide and copper oxychloride.

It has also been found that sprays need not be applied early, as was formerly the general practice, but can be used late when any tendency to injure is at a minimum. Moreover, delayed applications make it possible to avoid spraying altogether in dry years and thus save expense. On the basis of preliminary tests it appears that the first treatment need not be made before July 15. In dry years one application should suffice. In moist years two more, one on August 1 and one on August 15, should be applied.

Fungicides on Vegetables

Just now large numbers of new materials are appearing as vegetable sprays or dusts. Some of these are better than the old; some are inferior, while others are merely different. The Station has undertaken the problem of evaluating all of them and of developing new and, perhaps, better materials.

Until recently Bordeaux mixture was standard for vegetables. Formerly, it was also standard on fruit trees, but injury from the copper ingredient soon forced it almost out of that field. Sulfur materials, although generally inferior to Bordeaux for fruit disease control, are preferred because they give better finish on the fruit and less injury.

Vegetable spraying is passing through a similar phase. We are now finding that vegetables are sensitive to Bordeaux injury caused by the

lime rather than the copper content. The injury is not so apparent as fruit russet. The sprayed plants are only dwarfed and the blossoms are killed. The yield of vegetables is thereby reduced, especially in a disease-free year.

The problem is to devise and test new, lime-free copper fungicides. This the Department has been doing.

Squash Foot Rot

One of the highlights of 1939 in plant pathology was the sudden occurrence of a new squash foot rot which swept through the Early Prolific crops chiefly in New Haven County. The disease struck at the crown of the plant and hence is called foot rot. Speedy recognition of the trouble and intensive study of it showed that the cause was a fungus (*Fusarium* sp.), that it probably came into Connecticut with seed, that it grew out from diseased plants into the soil, that plants reseeded into such contaminated soil became diseased, and that varieties do not seem to differ in susceptibility.

It would be unfortunate if this new disease became established in Connecticut soils. Whether it can establish itself or not must await 1940. In the meantime growers who had the trouble last year should not reseed the land to cucurbits next year nor plant any seed procured from diseased squash.

Investigations of "X" Disease of Peach

"X" disease of peach was first recognized in Connecticut. Its origin is not known but it was discovered in 1933 through the vigilance of the Station staff. Vigorous research was instituted and it was soon found that the malady belonged to that baffling class of diseases caused by viruses. Hence it was characteristically labelled "X Disease"—cause unknown.

Search for a second host soon disclosed that the disease occurs on fence row choke cherries growing around peach orchards. From this wild host it spread to peach and then from diseased to healthy peach. The obvious check was to remove diseased trees and choke cherries in or near peach orchards.

Orchards in disease areas were chosen to test this control theory. Choke cherries were removed from some and not from others. After four years the disease ranged from 0.5 to 5 percent in treated orchards as compared with an average of 18 percent diseased peach trees in orchards where choke cherries were not removed.

In 1939 it was found that "X" disease could be transmitted within the first year by budding. This will speed up the research on the nature of the disease and lead to further knowledge of control methods.

Apple Spraying

In coöperation with the Entomology Department a section of the apple orchard at the Mount Carmel farm was sprayed with various materials for the control of insects and fungi. Dry lime sulfur with a water-

proof casein glue for a spreader and sticker gave good commercial control of cedar rust on Wealthy. Combinations of sulfur and copper sprays were tried with no very striking results in the control of apple scab. The combination of arsenate of lead, hydrated lime and fish oil still continued to give excellent results, both as a fungicide and insecticide on scab resistant varieties. Agreeable to the original plan of this work, which was to adjust the schedule to the apparent necessity of the season, the pre-pink spray was omitted on McIntosh with no evident loss of efficiency in scab control.

The Department is fully aware that Connecticut has a large urban population and that interest in ornamental plants is leaping ahead. This growing interest is reflected in the mail bearing requests for disease information. In recognition of the problem, several plantings of ornamentals have been made at the Mount Carmel farm in preparation for experiments on control measures. This work is done in coöperation with the Entomology Department. As far as its facilities will permit, the Department is also engaged in research on diseases of chrysanthemum, geranium, rose, daphne, elm, maple, and fir. Since facilities and personnel are rather limited, it is clear that many serious problems in this field can be looked at hopefully, but not attacked vigorously.

Progress with the foliar nematode on chrysanthemum was encouraging in 1939 although the disease was much less prevalent than in 1938, presumably because the season was drier. It can be deduced from the 1939 experiments that thorough sanitation in the greenhouse is essential to kill nematodes inhabiting the premises. Distinct advances were made in treating the chrysanthemums with hot water to kill the nematodes on the plants. A combination of the two procedures gives promise of solving this problem. More work needs to be done on tolerance of the plants to hot water.

The cause of the geranium root rot has been shown to be a fungus and a paper on this subject is in preparation.

A new sulfur fungicide was discovered for rose diseases during the year. The New Haven municipal rose garden will try it in 1940.

The Dutch Elm Disease

One of the functions of a plant disease department is to maintain contact with laboratories over the world in order to be aware of new disease menaces. The Dutch elm disease is a case in point. As early as 1928 Dr. Clinton decided to familiarize himself with the Dutch elm disease, a malady then sweeping over Europe. He interviewed European plant pathologists who knew the disease, and traveled abroad to study it himself in order to be prepared as well as possible for the advent of the trouble in this country.

As he feared, the Dutch elm disease invaded America in 1930 and since then has steadily marched ahead. Dr. Clinton searched for it along the roads and in the woodlands of Connecticut. When it was found here in 1933, he and Dr. McCormick confirmed the diagnosis.

The Department maintained an active interest in the problem and

confirmed numerous diagnoses in 1939. Now that the disease is becoming more widespread in Connecticut, we are ready to enlarge our interest in research.

Seed Testing

Seed testing in Connecticut dates back many years when Connecticut pioneered in this field. In 1939 the Department tested 250 samples of field seeds and 31 lawn mixtures for purity and germination, 250 lawn mixtures for purity, 8 hay and pasture mixtures for purity and 2,055 samples of vegetable seed for germination. The above samples were submitted by the Commissioner of Agriculture as provided in the Connecticut seed law. Besides these, numerous samples of lawn mixtures, field seeds, vegetable and grass seed were tested for the State Purchasing Department, the Highway Department, the Federal Soil Conservation Service, private individuals and seedsmen.

The use of glass wool as a substratum was originated in this laboratory. It has been a very successful medium for all grass seeds and many vegetable seeds including lettuce, endive, spinach and celery which are often difficult to germinate. The wool is cut in circular pads, moistened with water or a solution of potassium nitrate and put in petri dishes. No further moistening is required during the germinating period. The roots of the developing seed do not stick to the glass wool as they do with materials previously used. This facilitates the work of counting. Since the wool is completely inert, it offers no possible chance of injury to the seeds from chemicals sometimes present in processed materials such as blotters or cotton pads.

SOILS

Swamp Muck and Peat for Soil Improvement

War in Europe makes it necessary to substitute native muck for the imported peats commonly sold here for garden and horticultural use in past years. There is an abundance of material in local swamps and bogs and already several firms have offered native products for sale on the market.

A series of 12 humus materials has been studied at the Station with respect to their chemical fertility and effects on the physical properties of the soil to which they have been added.

Six of the samples were from Connecticut swamps, two from New York, one from Florida, one from Michigan, one from Maine and one from Sweden. The moisture contents of the Connecticut humus materials averaged approximately 70 percent as received, and supplied about 350 pounds of dry matter, containing 250 pounds of actual organic substance, per cubic yard. The two New York swamp peats were in a similar condition. The Florida peat is sold in crates of 200 pounds each, supplying about 120 pounds of humus. The Swedish moss peat, in an air-dry state, was packed in bales containing about 150 pounds of practically pure humus material. The Michigan and Maine peats are furnished in bags in a semi-moist state (containing 50 to 60 percent of water), supplying the equivalent of about 45 pounds of dry peat per 100-pound bag.

Soil Leaching Studies

Following a year of phenomenally high rainfall and excessive leaching due to the percolation of the surplus water through the soil, the 1939 season has been exceptionally free from leaching. Rainfall at Windsor was fairly adequate from the standpoint of crop growth, but the distribution of rains was so well scattered that little or no water was leached from the soil from early spring until late fall. Fall-seeded winter cover crops grew vigorously as a result of available nitrogen residues that had not been washed away. Conditions contrasted sharply with those following the 1938 season. At that time fall-seeded cover crops grew very poorly in the severely leached land and were thus of little benefit in conserving available plant food against late fall and early spring leaching.

A final report on seasonal water and nitrate nitrogen leaching on four different soils treated with nitrate of soda, sulfate of ammonia, urea and cottonseed meal has been issued as Bulletin 429.

In May, 1939, we completed 10 years of records on a series of lysimeter tanks that compared leachings and crop removals from 15 different sources of fertilizer nitrogen. The soils were cropped to tobacco this year without further treatment, to obtain residual effects. The indications are that no inorganic or synthetic nitrogen material has caused any significant "carry-over", that natural organic materials have had very small residual effect and that manure is superior from this standpoint.

Comparisons of acid forming nitrogenous fertilizers, with and without neutralization by equivalent amounts of lime, were concluded in May, after five years of study. The soils are being analyzed for residual effect in relation to leaching.

A new series of lysimeter trials was started in May, 1939. This involved a study of the acid-base balance of fertilizer chemicals, with comparisons between corresponding amounts of the chloride, sulfate, carbonate, and dihydrogen-phosphate of each of the following bases: calcium, magnesium, potassium and sodium. In all cases the materials are subject to the activity of nitrates formed from urea nitrogen in equivalent quantities.

Soil Treatments for Vegetable Crops

Fertilizer, manure and lime trials with a number of early and midseason vegetable crops have been conducted at Windsor for 10 years, ending with the 1939 season. Plots that received a total of 400 tons of cow manure during the experimental period gave only 16 percent larger average yields in 1939 than the best fertilizer treatment with no manure during the experiment, but with a winter rye cover crop each year and with buckwheat, millet or sudan grass as a late summer green manure crop every second year. A fertilizer in the 1-1-1 ratio, equivalent to 1,200 pounds of a 10-10-10 grade, has been best for most crops, when used without manure. Exceptions are peppers and sweet potatoes, favored by the equivalent of 1,000 pounds of the 4-16-20 grade. The same amounts of plant food in high analysis fertilizers, as compared with medium analysis formulas, have given slightly better yields in this season of little or no leaching.

A new series of humus treatments was started in 1939, but the data showed no consistent advantages for such soil amendments during this first year of the trials.

Boron Deficiency in Soils

During the year a number of cases of suspected deficiency in boron were observed. Most of these were in orchards, resulting in symptoms of "internal cork" and "drought spot" of the fruits of MacIntosh and Cortland apple varieties. The Soils Department is coöperating with the Analytical Chemistry Department and with the Storrs Agricultural Experiment Station in studies of these soils and of soils from alfalfa plots at Storrs that showed definite correction of abnormal drought injury from the use of borax.

Apple Root and Soil Moisture Studies

Apple trees, toppled by the hurricane of 1938 and set up by props or guy wires, were examined in a number of orchards, chiefly for the reestablishment of roots broken by the storm. Supplementary root distribution and soil moisture studies were conducted in the Barnes Nursery and Orchard Company orchard during the August drought. The greatest drain on soil moisture occurs from 6 to 10 feet from the trunk, for a 25-year-old tree. Here the soil was dried materially by the tree roots to the depth of about 2 feet, while in the grass covered area beyond the spread of the branches the soil was undepleted by vegetation below a 9-inch depth.

Soil Testing

The Station has tested about 6,500 soil samples at Windsor and New Haven during the past year. Calibration of soil test results with many soils of known history and crop response has been continued. A coöperative project with 14 other stations involves comparisons of the results of various methods on 30 soils of varying degrees of fertility from 15 different states.

Fertilizer Ratios

This Station has coöperated with the Agronomy and Horticulture departments at the University of Connecticut, and with the extension services and experiment stations of other New England states, in a study of fertilizer recommendations based on the use of fertilizer grades in simple, definite ratios. The ratios favored for New England conditions by a conference held with the fertilizer industry at Boston, December 2, 1938, are as follows: 0-2-1, 0-1-1, 1-4-1, 1-4-2, 1-4-5, 1-3-1, 1-2-1, 1-2-2, 2-4-5, 5-8-7, 1-1-1, and 2-1-1. A later conference at Farmington, Conn., on January 6, 1939, accepted the following ratios for tobacco: 2-1-2, 7-3-7 and 1-1-3. Some of these may not be needed for Connecticut conditions. Suggestions for suitable uses of grades in desirable ratios are being prepared for publication.

Forest Soils

Response of Ash Trees to Soil Fertility in Station Frames

A set of concrete soil frames, which has been fertilized regularly over a period of years, was planted to white ash in the spring of 1937. At the end of the third season, 1939, the average green weight of the wood per

tree ranged from about 100 grams on the poorest frames to 250 grams on the best. Nitrogen caused the greatest increase in growth, especially when lime was included, while phosphorus was only moderately effective. This is shown in the following data:

Grouping of Treatments	Mean Weight per tree gms.	Increase gms.	Increase %
All plots without lime	131.4	34.6	26.4
" " with lime	166.0		
All plots without nitrogen	110.6	76.3	69.0
" " with nitrogen	186.9		
All plots without lime or nitrogen	123.2	102.0	82.7
" " with lime and nitrogen	225.2		
All plots without phosphorus	138.8	19.8	14.3
" " with phosphorus	158.6		

In a previous study on these same soil frames, sugar maple responded somewhat similarly, with nitrogen and lime causing the greatest increase in growth. Red oak, on the other hand, made 17 percent less growth on the limed frames than on the unlimed frames. The average increase for nitrogen was 28 percent over the no-nitrogen frames, while phosphorus gave only an 8.5 percent increase.

None of the humus materials used in these trials is able to supply more than insignificant amounts of available chemical fertility when used in the proportion of one to three by volume, mixed with a practically sterile sandy soil. One ton of dry peat (equivalent to nearly six cubic yards of moist swamp peat, or to 13 bales of dry moss peat, or to over two tons of semi-moist bagged peat) supplied available plant food during six months of cropping in the greenhouse corresponding to approximately the following amounts of fertilizer, on the basis of the averages for the 12 materials:

5 pounds of a 16 percent nitrogen fertilizer
3 pounds of a 20 percent phosphoric acid fertilizer
.5 pound of a 60 percent potash fertilizer

These amounts would be approximated in 10 pounds of an 8-6-4 fertilizer, costing only a few cents.

The chief value of peat or swamp muck is in their ability to improve moisture retentiveness of soil, preventing it from becoming hard and cloddy when dry or, in case of a clay soil, tough or sticky when wet. Local swamp humus is able to absorb water equivalent to from five to six times its dry weight. Baled moss peat is superior in this respect, holding water up to about 13 times its dry weight. However, in contact with the soil for several months, the increased water absorption of the mixture represents only two or three times the original dry weight of the humus material added. A sandy soil of poor humus content may be greatly improved in moisture retentiveness by additions of moss or swamp peat.

In these trials, the untreated soil became dry to the wilting point in two weeks while the treated soils still contained available water, in excess of the wilting point, equivalent to about 250 gallons per 1,000 square feet, on the basis of a 3-inch depth of soil mixed with 2.5 cubic yards of moist swamp peat, or 800 pounds of semi-moist bagged peat, or 5 bales of dry

moss peat, per 1,000 square feet. The untreated soil, when dry, was much harder and more cloddy when cultivated than any of the treated soils. The swamp peats appeared to be superior to the moss peat in this respect, when mixed with the soil.

Fertilizing Sweet Potatoes

There are many soils in Connecticut, too sandy for best results with white potatoes, that are especially adapted to sweet potatoes. The 1939 season completed seven years of comparisons between sweet potatoes (Longstem Jerseys) and white potatoes (Cobblers) on the vegetable fertilizer plots at Windsor. Pertinent yield data are as follows:

	Bushels per Acre			
	Average of all plots	Heavily manured (no fertilizer)	Best fertilizer treatment (no manure)	Half-rate fertilizer treatment (no manure)
Sweet Potatoes	296	406	295	256
White Potatoes	190	229	211	156

The best fertilizer treatment for sweet potatoes, in these trials, supplied the equivalent of 1,000 pounds of 4-16-20 grade per acre. For white potatoes, best yields were obtained from the equivalent of 1,500 pounds of an 8-8-8 grade per acre. The high yields of sweet potatoes on the heavily manured plots were obtained at a sacrifice of quality. The potatoes were notably irregular in size, badly discolored, and more than ordinarily subject to black rot disease.

Another field of considerably more sandy soil than represented by the above trials has also been used for sweet potatoes. Yields in this fertilizer ratio experiment averaged 237 bushels per acre for five years from the equivalent of 600 pounds per acre of a 4-16-20 fertilizer, the best treatment in this series of tests. This coarse, sandy soil produces the medium-sized potatoes of uniform shape that are popular on the market.

Chemical Fertility of Pasture Soils

Available phosphorus is low in pasture soils of Connecticut according to results of laboratory and pot culture tests during the past two years. A group of 15 representative soils were used in the studies. Good, fair and poor grazing conditions were each represented by five soils. The following table summarizes the results of two series of pot tests, using tobacco as an indicator of fertilizer response.

	Relative Production, Complete Fertilizer = 100			
	Without Nitrogen	Without Phosphorus	Without Potassium	Average pH
Good pasture soils	65.4	35.9	77.0	5.65*
Fair " "	57.3	20.6	54.5	5.30
Poor " "	44.9	13.1	47.0	5.00*

*excepting one calcareous soil in the group.

As in previous studies on pasture soils, phosphorus is quite generally the most important limiting factor, associated with a serious need for lime in most cases. Potassium is notably better supplied in the more favorable

soils. It is apparent that even in the best group, the availability of soil phosphorus is at a relatively low level. This is in line with the results of both rapid chemical tests and detailed laboratory analyses.

Chemical Fertility of Vegetable Field Soils

Vegetable cropping tends to deplete the readily available nitrogen of the soils. The liberal fertilizer treatment commonly used for such crops builds up the soil to a relatively high degree of chemical fertility with respect to both phosphorus and potassium, as compared with practically untreated pasture lands. During 1939 a group of nine typical soils were studied for the intensive production of vegetables.

Preliminary chemical tests had revealed a condition of low phosphorus availability on Soil 469 from the Lee Farm of the University of Connecticut, and of low potassium availability on Soil 472 from the Eastern States Farm at Ellington, Conn. (These were being prepared for vegetables, but previously had been used for general farm crops). All other soils gave relatively high tests for both phosphorus and potassium.

The yield of the first crop of tobacco grown in Soil 469, without any phosphorus in the fertilizer, was only 4.46 grams per pot. The average for the eight other soils, on which production ranged from 14.53 grams to 29.47 grams for the different samples, was 23.45 grams per pot. The yield of two crops of tobacco grown on Soil 472, without potash, averaged 10.06 grams per pot, as compared with the 29.51 grams per pot average of the eight other soils (ranging from 22.33 grams to 35.48 grams for the different samples). Phosphorus deficiency is more evident on the first crop grown after removal from the field, while potash deficiency is most consistently measured by the average of the first two crops in the pot trials.

It is of interest to note the relative response of the vegetable soils as compared with the pasture soils noted in the preceding section.

	Relative Production Complete Fertilizer = 100		
	Without Nitrogen	Without Phosphorus	Without Potassium
Vegetable Soils (9)	29.5	81.8	79.0
Pasture Soils (15)	55.9	23.2	59.3

Soil Fertility Studies in the Forest Nursery

Previous investigations on the use of fertilizers in the forest nursery dealt chiefly with red pine, one of the least responsive of the common tree species. The results, which appeared in Bulletin 416, showed that, in general, fertilized trees made somewhat better growth than the unfertilized, although the increase was seldom large.

During the past summer a new series of experiments was carried on at Peoples Forest Nursery. In these three levels of nitrogen, phosphorus and potash were applied in soluble form to the seedbeds and to parts of the transplant beds at intervals during the summer. The rest of the transplant beds were given a treatment of dry mixed fertilizer, worked into the soil prior to planting.

The results of the first season's work show that in the 2-0 seedbeds all treatments produced plants superior to the checks, and that some of the mixtures were better than the sulfate of ammonia treatment commonly used at this nursery. Trees from all treatments have been put in the transplant beds, and further data will be taken on the growth next season.

In the transplant beds, the dry fertilizer applied prior to planting appeared to favor growth equally with the liquid fertilizer. With the 4-12-4 fertilizer, 2,000 pounds per acre was better than either 1,200 or 400 pounds; but in the case of the 12-4-4 mixture, the order of superiority was 400, 1,200 and 2,000.

The work is to be continued.

Forest Lysimeter Studies

At the end of the first year of the forest lysimeter experiments, the amount of nitrogen leached out of the soil ranged from one pound per acre in the bare soil of the pan lysimeters (those with normal root competition) to 111 pounds from the bare soil of the tank lysimeters (those without root competition). Humus alone, without root competition, gave up 56 pounds, while humus alone with root competition lost only 12 pounds. From the soil with the natural humus cover left in place, the respective figures are 77.0 and 1.7.

In the fall the nitrate nitrogen content of the soil in the tanks tended to increase until about December 1. The highest concentration was 152 p.p.m. The leachate from the pan lysimeters, on the other hand, rarely contained as much as one p.p.m.

Effect of Slash on the Soil

Some investigators have reported that slash has a marked beneficial effect on the growth of young trees on sandy soil. The immense amount of slash left by the hurricane at the Rainbow forest plantation is providing an opportunity to study the effect of several methods of slash disposal on the soil and, later, on the growth of plantings. Plots kept free of slash are being compared with those on which the slash is of normal thickness, of double thickness, and where it is burned and the ash scattered over the plot.

TOBACCO SUBSTATION

New Building for Tobacco Research

THE ERECTION of a larger and better building to house the laboratories, sorting rooms and offices of the Substation marks the beginning of a new period of progress in tobacco investigations in Connecticut. The building is not yet completed but will probably be ready for occupancy next summer. The Department long since outgrew the small wooden building in which it had been crowded since the Tobacco Substation was started in 1922. Moreover, the old building is not fireproof and offers no security for the valuable research records, the most complete collection of photographic

negatives on tobacco in New England, an excellent tobacco library and the scientific equipment assembled here. The new building, made of brick, concrete and steel is completely fireproof and will insure the safety of the property.

The handsome colonial structure of Christopher Wren style measures 66 by 34 feet, and has two stories and a basement. In the basement are a modern sorting shop and conditioning room for grading tobacco, two completely equipped photographic rooms, laboratories for chemistry, soils and entomology, a work shop and a boiler room. The building is heated with hot water from an oil-burning furnace. On the first floor are a general office and separate offices for the director, agronomist, entomologist, chemist and physiologist, a plant pathology laboratory and a library and conference room. On the second floor is a large auditorium for meetings of growers and room for four additional offices or laboratories. A cupola over the roof furnishes shelter for weather instruments.

The old building was made possible by funds contributed by the tobacco growers' organization, The Connecticut Valley Tobacco Improvement Association. The new building is being constructed under the supervision of the State Public Works Department, the funds being contributed jointly by the State and the Works Progress Administration.

Direct Service to Growers

One of the phases of growth that has made a larger building necessary is the direct services to growers. This branch shows an increase every year. Between four and five thousand samples of soil annually are brought to the Station for analyses as a basis for fertilizer treatment and for conference with the agronomist. These samples for the most part are from tobacco fields, but an increasing number comes from fields of other farm crops, vegetables, orchards and lawns and flowers, as the growers are convinced of the value of these tests. Several hundred samples of tobacco seed are brought or sent in for germination tests and cleaning every year. Since the Tobacco Substation is within a half hour's drive of most of the tobacco farms of the State, many growers consider it profitable to call at the Station occasionally for conference with members of the staff. This type of service is time-consuming but effective. It has been supplemented during the year by a few public gatherings of growers, by publication of bulletins and circulars, and by farm visits.

Change in Staff

In August Dr. O. E. Street, who has been the Physiologist and Chemist of the Tobacco Substation since 1929, resigned to take a post with the U. S. Department of Agriculture in charge of tobacco investigations at Lancaster, Pennsylvania. During his 10 years at Windsor, Dr. Street made valuable contributions to our knowledge of tobacco culture, particularly by his investigations of the processes of curing and fermentation, the leaching of plant nutrients from tobacco soils and correlation of growth with absorption of nutrients. His successor, Dr. Stuart LeCompte, of Baltimore, comes from Johns Hopkins University and will take up his duties at Windsor in March.

Further Investigations of Downy Mildew of Tobacco

Investigation on methods of controlling downy mildew, the most recent of tobacco disease arrivals in Connecticut, has been continued. The disease was less prevalent in the seedbeds in 1939 than during the two preceding years, but it was distinctly more destructive in the field. In the seedbed experiments, comparing the benzol method of "gassing" with the paradichlorobenzene method, it was found that either was satisfactory when the temperature was not below 50 degrees F. At the lower temperatures, often prevailing in beds in early spring, the vapors from paradichlorobenzene fail to build up to a concentration sufficient to insure full control. Under these conditions, benzol seems preferable to paradichlorobenzene. Further experiments, with wick evaporators, in place of shallow pans to hold the materials, indicate some distinct advantages in this method of vaporizing the benzol. It saves time and labor but is more expensive to install. The Substation Report for 1939 contains a full description of the wick experiment.

No satisfactory method of controlling mildew in the field has been found. At present there are two obvious lines of attack. Since there is strong evidence that most, if not all, the field infection originates with diseased plants in the beds, every effort should be made to keep the seedbeds free from disease. The second possibility is to develop resistant strains of tobacco. The fact that during 1939 the different strains grown under cloth in the field showed marked differences in amount of damage from mildew is reason for believing that more resistant strains can be developed. Shade tobacco is the only variety seriously injured in the field.

Fertilizer Experiments

Experiments to compare the various sources of food elements for the plants have always occupied a large part of the tobacco farm and probably will continue to do so as long as new fertilizer materials are being introduced. Most of these are long-term tests and little can be said about results for a single year. Some of the more recent developments may be mentioned briefly:

Soybean Oil Meal for Cottonseed Meal

This is perhaps the outstanding change that is taking place in tobacco fertilization practice. Cottonseed meal, the standard organic base for nearly all mixtures for the last half-century, is very rapidly being replaced by soybean oil meal. Our experiments continue to show that the soybean product is not only as good but that on the average it produces a little better quality of tobacco and the acre yield is at least as high. Soybean oil meal contains more nitrogen than cottonseed meal and, calculated in price per pound of plant food, the soybean product is less expensive than the cotton product. Present trends in the United States indicate that there will be an annual increase in the already adequate supply of soybean meal while the tendency of the cotton product is toward a decrease.

The European War and Potash for Tobacco

The war in Europe may be instrumental in developing an American market for certain native potash carriers. Sulfate of potash, the standard

potash compound for tobacco mixtures, has always been imported from Germany or France and very little is produced in the United States. The same is true of nitrate of potash. America has large sources of muriate of potash but this is not suitable for tobacco. In a long series of experiments at the Substation, it was shown that there are two kinds of potash carriers that are superior to sulfate. The first is ground tobacco stems, a by-product of nicotine extraction, more expensive to use than the sulfate but producing better tobacco. The second is cottonhull ash, a by-product of the cotton-ginning industry in the South. We believe that this also is superior to sulfate and it costs about the same. Both are American products and there is an adequate supply for our needs.

Sludge as a Tobacco Fertilizer

At the new sewage-disposal plant for the Hartford Metropolitan District great quantities of dry, organic material known as sludge are accumulating for which no practical use has been found. Although there is little available plant food in this material, large amounts of it were used on plots at the farm to test its value as a soil amendment. Regular fertilizer was applied in addition. The immediate effect was reduced yield. Further experiments are under way to see whether there is a beneficial residual effect or whether different rates of application might give better results.

Ammonification of Nitrogenous Fertilizers

Although a number of investigations have been made on nitrification, very little has been done on ammonification of tobacco fertilizers. This process precedes nitrification and may explain some of the differences in behavior of fertilizers. Weekly tests of the soil on the single-source-of-nitrogen series of plots for both ammonia and nitrates were started in the 1939 season and are giving interesting and significant results. These experiments will be continued through several years so that results under different seasonal conditions may be compared.

Optimum Quantity of Calcium for Tobacco

The supply of calcium in the soil seems to have an important effect on the quality and quantity of tobacco. In these field plots various quantities of calcium are applied without disturbing the soil reaction. This is the fourth year of this experiment.

Substitution of Urea for Organic Nitrogenous Materials

Field tests over a four-year period indicate that the tobacco plant utilizes nitrogen in urea to a greater degree than it uses an equivalent amount of nitrogen in organic meals.

Irrigation of Tobacco

The value of irrigating tobacco during a dry year is a disputed practice among growers. As often as a dry year furnishes an opportunity for experiment, some plots at the farm are irrigated, some are irrigated and nitrate added, while others are not treated. Results up to the present have been favorable to irrigation with the addition of nitrate. The season of 1939 was dry enough to warrant irrigation for only a short time but results are in line with those previously obtained.

Fertilizer Placement Tests

Ordinarily all the fertilizer for tobacco is broadcast and harrowed in previous to setting. For various other crops it has been shown that better results can be obtained by sowing the fertilizer in, or very near, the row. Consequently, tests are being conducted here on tobacco in which the fertilizer is distributed in bands at the same depth as the roots but three or four inches to either side of the plants in the row. The application is made from a fertilizer hopper attached to the transplanter so that setting and fertilizing may be accomplished in one operation.

Time of Harvesting Havana Seed Tobacco

The object of the "time of Harvesting" tests is to determine how long tobacco should be left in the field after topping to secure the best quality and maximum weight. The detailed reports of experiments covering five years are given in Bulletin 432. In general, results indicate that an interval of three weeks is about optimum.

Insect Investigations

Investigations on insects are concentrated on wireworms, flea beetles and thrips in coöperation with the U. S. Department of Agriculture. Practical control for flea beetles has been accomplished and good progress has been made on thrips. No satisfactory control for wireworms has yet been found.

THE LIBRARY

During the year ended October 31, 1939, the Station Library has had approximately the following number of additions:

U. S. Department of Agriculture publications	745
State Agricultural Experiment Station publications	879
Scientific and agricultural domestic and foreign journals (separates)	2,275
Single books purchased	57
Total	3,956

The library subscribes to 90 sets of scientific journals. It receives in return for the publications of this Station about 25 sets of domestic farm journals and 26 sets of foreign agricultural journals.

The total number of cloth and paper bound volumes on hand is now about 26,000. Most of the United States Department of Agriculture and State Experiment Stations publications, as well as scientific journals, are received in pamphlet form and are not included in the volume count until bound.

PUBLICATIONS

July, 1938 to July, 1939

BULLETINS OF THE STATION

A Survey of Diseases and Defects in Connecticut Forests. Raymond Kienholz and C. B. Bidwell. No. 412.

Red Pine in Connecticut Forest Plantations. I. Volume Tables for Red Pine, *Pinus Resinosa*, Solander. H. W. Hicock and Raymond Kienholz. No. 413.

Commercial Feeding Stuffs. Report on Inspection, 1937. E. M. Bailey. No. 414.

Report on Food Products and Drugs for 1937. E. M. Bailey. No. 415.

The Use of Fertilizer in the Coniferous Nursery, with Special Reference to *Pinus resinosa*. H. A. Lunt. No. 416.

Commercial Fertilizers. Report for 1938. E. M. Bailey. No. 417.

The European Red Mite and Its Control. Philip Garman and J. F. Townsend. No. 418.

Hibernation of the Corn Ear Worm in Southern Connecticut (U.S.D.A. in coöperation with The Conn. Agric. Expt. Station.) G. W. Barber. No. 419.

The Native Elm Bark Beetle, *Hylurgopinus rufipes* (Eichhoff), in Connecticut. B. J. Kaston. No. 420.

Annual Report for the Year Ending October 31, 1938. No. 421.

Tobacco Substation at Windsor. Report for 1938. P. J. Anderson, T. R. Swanback and O. E. Street. No. 422.

The Soil Characteristics of Connecticut Land Types. M. F. Morgan. No. 423.

Chemical Investigations of the Rhubarb Plant. H. B. Vickery, G. W. Pucher, A. J. Wakeman and C. S. Leavenworth. No. 424.

Commercial Feeding Stuffs. Report on Inspection, 1938. E. M. Bailey. No. 425.

CIRCULARS OF THE STATION

The Use of Water Soluble Preservatives in Preventing Decay in Fence Posts and Similar Materials. H. W. Hicock. No. 123.

Law and Regulations Concerning the Inspection and Shipment of Nursery Stock in Connecticut. W. E. Britton. No. 124.

Regulations Concerning Transportation of Nursery Stock in the United States and Canada. W. E. Britton. No. 125.

Control of the Rosy Apple Aphid in Connecticut Apple Orchards. Philip Garman. No. 126.

Soil Testing Methods. The Universal Soil Testing System. M. F. Morgan. No. 127.

Control of Tobacco Mildew (Blue Mold) in Seedbeds. P. J. Anderson. No. 128.

The Sand Culture of Seedlings and Mature Plants. A. A. Dunlap. No. 129.

Control of the European Corn Borer by Sprays and Dusts. Neely Turner. No. 130.

Soil Testing in Connecticut. M. F. Morgan, T. R. Swanback and J. S. Owens. No. 131.

Control of the Japanese Beetle. J. P. Johnson. No. 132.

Control of European Corn Borers on Dahlias. Neely Turner. No. 133.

Control of Termites in Buildings. Neely Turner and J. F. Townsend. No. 134.

The Law Concerning Concentrated Commercial Feeding Stuffs and Regulations Pertaining Thereto. No. 135.

Report on Commercial Insecticides and Fungicides, 1939. H. J. Fisher. No. 136.

JOURNAL PAPERS

Botsford, R. C. Progress of mosquito control in Connecticut. N. J. Mosq. Extermin. Assoc. Proc., pp. 127-132. 1939.

Britton, W. E. Additions to the check-list of the insects of Connecticut. State Geological and Natural History Survey, Bul. 60. 1938.

Clark, F. J. A gene for abnormal meiotic spindle formation in maize. Genetics, 24: 68. 1939.

Dunlap, A. A., and McDonnell, A. D. Testing germination in sand. Journal of Forestry, 37: 330-332. 1939.

Fisher, H. J. Report on santonin, phenolphthalein and calomel. Jour. Assoc. Off. Agr. Chem., 21: 531. 1938.

————. Report on pyridium. Jour. Assoc. Off. Agr. Chem., 21: 552. 1938.

Friend, R. B. The relation of insects to the conservation of farm woodlots. Jour. Forestry, 36: 1004-1011. 1938.

————. The spruce sawfly (*Neodiprion polytomum* Htg.) and the European pine shoot moth (*Rhyacionia buoliana* Schiff.). Proc. Eastern Shade Tree Conf., pp. 50-53. 1938.

Garman, Philip. Effectiveness of parasites for controlling the Oriental fruit moth. Mass. Fruit Growers' Assoc. Report, pp. 70-74. Jan., 1939.

Jones, D. F. Crops and forests: Their production, protection and use. Seventh International Management Congress. Sept., 1938.

————. Growth changes associated with chromosome breakage and reattachment. Genetics 24: 77. 1939.

————. Nuclear control of cell activity. Science, 88: 400-401. 1938.

————. Sex intergrades in Dioecious maize. Amer. Jour. Bot., 26: 412-415. 1939.

————. Utilization of plant resources. Seventh International Management Congress, Washington, D. C. Sept., 1938.

Kaston, B. J. New spiders from New England with notes on other species. Bul. of Brooklyn Ent. Soc., 33: 173-191. 1938.

————. A note on synonymy in spiders (Araneae: Salticidae and Argiopidae). Ent. News, 49: 258-259. 1938.

————. North American spiders of the genus Agroeca. The American Midland Naturalist, 20: 562-570. 1938.

————. Notes on a new variety of black widow spider from southern Florida. The Florida Ent., 21: 60-61. 1938.

————. Check-list of the spiders of Connecticut. Conn. Geol. and Nat. History Survey, Bul. 60, pp. 175-201. 1938.

McCormick, F. A. "Cephalosporium Die-Back" of elms. Phytopath, 29: 371-372. 1939.

————. Theilaviopsis basicola (Berk.) Ferraris on geranium in Connecticut. Plant Disease Reporter, 23: 88. 1939.

————. The willow scab, Fusicladium saliciperdum. Tree Pest Leaflets, Mass. Forest and Park Assoc. June, 1939.

Morgan, M. F. Progress toward uniformity in fertilizer ratios and grades in the Northeastern States. Commercial Fertilizer Yearbook, pp. 48-51. 1939.

Morgan, M. F., Gourley, J. H., and Ableiter, J. K. The soil requirements of economic crop plants. Yearbook of Agriculture, U.S.D.A., pp. 753-776. 1938.

Pucher, G. W., Wakeman, A. J., and Vickery, H. B. Organic acid metabolism of the buckwheat plant. Plant Physiol., **14**: 333-340. 1939.

Pucher, G. W., Wakeman, A. J., and Vickery, H. B. The organic acids of rhubarb (*Rheum hybridum*). III. The behavior of the organic acids during culture of excised leaves. Jour. Biol. Chem., **126**: 43-45. 1938.

Singleton, W. R. Cytological observation on deficiencies produced by treating maize pollen with ultra violet light. Genetics, **24**: 109. 1939.

————————. Recent linkage studies in maize V opaque endosperm 2. Genetics, **24**: 61. 1939.

Stoddard, E. M. Fruit speck—an old apple disease with new ambitions. Pomological Pointers for Conn. Fruit Growers. March, 1939.

————————. The "X Disease" of peach. Rural New Yorker, **98**: 142. 1939.

————————. Progress report on the "X Disease" of peach. Conn. Pomol. Soc. Proc., **41**: 29. 1938.

————————. Report of committee on fungous diseases. Conn. Pomol. Soc. Proc., **41**: 79. 1938.

————————. Some timely thoughts on the "X Disease" of peach. Pomological Pointers. Sept., 1938.

Turner, Neely. Construction of metal termite shields. Pests, **7**: 16-17. 1939.

Vickery, H. B. The metabolism of proteins in green leaves. Cold Spring Harbor Symposia on Quantitative Biology, **6**: 67-77. 1938.

Vickery, H. B., and Pucher, G. W. The loss of carbon from excised rhubarb leaves during culture. Jour. Biol. Chem., **128**: 685-702. 1939.

Vickery, H. B., and Pucher, G. W. The metabolism of amides in green plants. III. The mechanism of amide synthesis. Jour. Biol. Chem., **128**: 703-713. 1939.

Vickery, H. B., Pucher, G. W., Leavenworth, C. S., and Wakeman, A. J. The metabolism of amides in green plants. II. The amides of the rhubarb leaf. Jour. Biol. Chem., **125**: 527-538. 1938.

LIST OF PROJECTS

1939-40

Analytical Chemistry

1. Inspection of fertilizers.
2. Inspection of feeding stuffs. (Including biological assays of fortified poultry feeds.)
3. Inspection of food and drugs. (Including biological assays of vitamin D milk.)
4. Calibration of Babcock glassware and thermometers.
5. Analyses of insecticides and fungicides.
7. Analyses of special and miscellaneous foods.
8. Collaborative studies on analytical methods.

Biochemistry

1. Cell chemistry.
   a. A detailed examination of the constituents of plant cells, in particular those of leaf tissues. The further development of methods for the determination of the different forms of nitrogen in such tissues.
   b. Chemical investigations of the constituents of the tobacco and other plants with special reference to the changes that occur during culture under various conditions.
   c. The metabolism of the organic acids in plants.
2. Protein chemistry.
   a. The methods for the determination of the basic amino acids yielded by proteins with the object of increasing their accuracy and convenience.
   b. The methods for the separation of other amino acids yielded by proteins.
   c. The properties of certain of the amino acids and their derivatives.
   d. Methods for the preparation of pure proteins.
3. Nutrition investigations.
   a. The relation of diet to the rate of growth with special attention to certain factors that appear to determine rapid growth.
   b. The investigation of the relation of certain constituents of the diet, in particular the mineral salts, to growth.

Entomology

3. Spraying and dusting experiments on apples and peaches. (See also Plant Pathology and Botany, No. 8.)
9. Insect survey of Connecticut.
17. Studies on the control of the Oriental fruit moth, including parasites. (In coöperation with the U. S. Dept. Agr.)
28. Investigations on oil sprays.
30. A study of insects that attack the tobacco plant. (In coöperation with the U. S. Dept. Agr.) (See also Tobacco Substation, No. 20.)
31. Studies on the biology and control of the European pine shoot moth.
32. The biology and control of the potato flea beetle.
34. Tests of methods to control clothes moths.
35. The biology and control of the white apple leafhopper.
36. Methods for the control of onion thrips.
37. Substitutes for lead arsenate in orchard sprays.
38. The relation of rate of growth and pruning methods to the recovery of white pine to weevil injury.
40. Studies of sprays and parasites for the control of the European corn borer. (In coöperation with the U. S. Dept. Agr.)
41. Studies on the corn ear worm. (In coöperation with the U. S. Dept. Agr.)
42. The biology and control of termites.
43. The spruce gall aphid.
44. Bark beetles of the elm.
45. Investigation of parasites of the Japanese beetle.
46. Study of the parasite, *Trichopoda pennipes* Fabr., of the squash bug.
47. Value of derris dusts in the control of aphids.
48. Study of predators affecting the European red mite.
49. Adhesives for standard spray mixtures.

Control and Service

10. Inspection of orchards and nurseries.
11. Control of the gypsy moth. (In coöperation with the U. S. Dept. Agr.)
13. Inspection of apiaries.
19. Control of European corn borer. (In coöperation with the U. S. Dept. Agr.)
24. Control of the Asiatic beetle.
25. Control of the Japanese beetle. (In coöperation with the U. S. Dept. Agr.)
27. Rearing and distributing parasites of the Oriental fruit moth. (In coöperation with the Conn. Pomological Society.)

Forestry

1. Experimental plantations on a sandy tract at Rainbow.
   a. Comparison of many species of conifers and hardwoods, in pure stands and in combinations.
   b. Methods of management for those species that have survived.
   c. Studies on growth and habits of the several species.
6. Studies of forest plantations throughout the State.
   a. Studies of growth and yield of the several species.
   b. Reasons for success or failure.
   c. Soil and other site factors necessary for success of each species.
10. An investigation of the distribution and growth of forest trees as influenced by soil conditions and other site factors. (See also Soils, No. 4.)
12. A study of preservative treatments of native woods. (In coöperation with State Forester, State Highway Dept., Conn. Forest & Park Assoc., Yale University, and U. S. Forest Service.)

Control and Service

5. Distribution of forest planting stock. (In coöperation with the U. S. Dept. Agr.)
7. Control of white pine blister rust. (In coöperation with the U. S. Dept. Agr.)
15. Control of Dutch elm disease. (In coöperation with the U. S. Dept. Agr.)

Genetics (Plant Breeding)

1. A genetic study of hereditary characters in corn involving their linkage relations and variability.
2. The effects of inbreeding and crossing upon corn.
3. Methods for the improvement of naturally cross-fertilized plants by selection in self-fertilized lines, with particular attention to field corn for grain and ensilage; alfalfa; and to some of the more important vegetable crops such as sweet corn for market gardening and canning, beets, cabbage, carrots, cucumbers, melons, onions, radishes, rutabagas, squash; and some fruits such as bush fruits and strawberries.
4. Methods for the improvement of naturally self-fertilized plants, with particular attention to tobacco, and vegetable crops such as lettuce, lima beans and tomatoes.
5. A study of variation and the effects of selection in strains of cross-fertilized and self-fertilized vegetables.

Plant Pathology and Botany

5. Plant disease survey of Connecticut.
8. Spraying and dusting experiments on apples and peaches. (See also Entomology, No. 3.)
20. Diseases of shade trees.
27. The Dutch elm disease and related diseases.
28. Studies on the identification of apple varieties by seed characters. (Inactive)
30. Diseases of vegetable crops and their control.
   a. Downy mildew of muskmelons and cucumbers.
   b. Defoliation and related diseases of tomatoes.
   c. Root rot of squash.

d. Wilt diseases of tomatoes and eggplant.
31. Investigation of a new peach trouble ("X disease").
33. Diseases of ornamental plants.
a. Geranium root rot.
b. Botrytis blight on tulips.
c. Root rot of delphinium.
d. Powdery mildew diseases—lilac, phlox, etc.
e. Rose diseases.
Powdery mildew.
Black spot.
f. Carnation and hollyhock rust.
g. Chrysanthemum nematode.
34. Fungicides, new and old.

Control and Service

12. Seed testing. (In coöperation with the Commissioner of Agriculture.)
25. Spray service. (In coöperation with Extension Service, University of Conn.)

Soils

2. The physical and chemical characteristics of important soil types in relation to the nutritive response of tobacco and other crops when these soils are variously treated in the greenhouse.
3. Nutrient requirements of vegetable crops on important soil types used for market gardening in Connecticut.
4. A study of the physical, chemical and biological conditions of several soil types in natural mixed hardwoods and in planted coniferous forests.
5. Lysimeter studies of the drainage losses and other changes that occur in several soils under heavy fertilization as practised for tobacco and vegetables.
6. Lysimeter studies of the composition of drainage water as affected by the forest floor.
7. The improvement of the nutritional status of unproductive forest soils.
8. The agronomic application of rapid chemical tests for estimating the nutritional factors of soil fertility.
9. The evaluation of various soil factors in terms of land use and types of farming.

Tobacco Substation

1. Fertilizer experiments.
ba. The efficiency of Urea nitrogen compared with organic nitrogen.
bb. The relative efficiency of nitrogen from castor pomace, soybean oil meal and cottonseed meal.
e. Comparison of various single sources of nitrogen.
fa. Comparison of sources of phosphorus.
fb. The relation of phosphorus absorption to calcium.
n. Fractional application of fertilizers.
p. Quantity of nitrogen in the fertilizer.
qa. Fertilizer placement tests.
3c. Slude from sewage disposal plant as a soil amendment.
4. Tobacco nutrition studies.
d. Symptoms of food element deficiency.
h. Ammonification and nitrification of fertilizer materials.
i. The effect of calcium on the growth and quality of tobacco.
5d. Comparison of Havana seed strains. (In coöperation with the U. S. Dept. Agr.)
7aa. Improvement of Shade tobacco by selection and breeding. (In coöperation with the Conn. Leaf Dealers Assoc.)
8b. Effect of cover crops on leaching. (See also Soils, No. 5.)
13. Preservative treatment of shade tent poles. (See also Forestry, No. 12.)
17b. The study of the cause of black Shade tobacco.
19. Investigation of various tobacco diseases.
c. Pole rot.
e. Breeding for mosaic resistant Broadleaf.
f. Control of downy mildew.

20. A study of insects that attack the tobacco plant. (In coöperation with the U. S. Dept. Agr.) (See also Entomology, No. 30.)
    a. Control of wireworms.
    b. Control of flea beetles.
    c. Control of thrips.
22. Irrigation of tobacco.
25. Spacing of Havana Seed tobacco.
26. Chlorpicrin for sterilization of tobacco bed soil.
27. Tests of lumarith for seed bed covers.
28. Use of cyanamid for control of weeds in seed beds.
29. Changes in fungus and bacterial flora during the fermentation of tobacco. (In coöperation with Bloch Bros. Tobacco Co.)
30. Chemical investigations. (In coöperation with the American Tobacco Co.)

All of which is respectfully submitted.

WILLIAM L. SLATE,

Director.

REPORT OF THE TREASURER

W. L. Slate, Treasurer, in account with the **Connecticut Agricultural Experiment Station.**

GENERAL STATION FUND

(Chapter 111 of General Statutes, Revision of 1930)

July 1, 1938 to June 30, 1939

RECEIPTS

Balance on hand July 1, 1938	.....
State Allotment	$65,773.20
	$65,773.20

DISBURSEMENTS

Personal Services:			
Salaries	$45,838.00		
Labor	5,717.50		
		$51,555.50	
Contractual Services:			
Telegraph and telephone	544.38		
Travel (outlying investigations)	1,493.16		
" (meetings, conferences, etc.)	524.96		
Freight, express and parcel post	20.77		
Publications (reprints, etc.)	56.63		
" (engraving)	3.97		
" (photographs for bulletins)	19.30		
" (other expenses)	99.22		
Gas and electricity	1,093.18		
Water	171.77		
Rent of equipment	15.00		
Insurance (fire and automobile)	957.99		
Miscellaneous contingent expenses	602.23		
Repairs to furniture and fixtures	69.00		
" " automobiles	272.89		
" " tools, machinery and appliances.	88.45		
" " buildings	609.72		
Nonstructural improvements	12.41		
		6,655.03	
Supplies and Materials:			
Stationery and office supplies	358.58		
Chemicals and laboratory supplies	203.22		
Spraying and dusting materials	37.67		
Photographic supplies	71.82		
Feeding stuffs	124.11		
Fertilizers	52.95		
Lumber and small hardware	19.79		
Miscellaneous supplies	584.40		
Automobile oil, alcohol, etc	52.33		
Postage	158.81		
Gasoline for automobiles	475.89		
Coal	2,196.14		
Material for repairs to furniture and fixtures	65.65		
" " " " scientific equipment	14.94		
" " " " automobile (accessories)	81.20		
" " " " tools, machinery & equipment	12.55		
" " " " buildings and grounds	289.27		
		$4,799.32	
Capital Outlay:			
Furniture and fixtures	$296.45		
Library (books and periodicals)	732.84		
Scientific equipment	490.86		
Tools, machinery and appliances	138.42	1,658.57	
Total disbursements			$64,668.42
Balance on hand June 30, 1939			1,104.78*
			$65,773.20

* Reverted to State Treasury

FOOD AND DRUG APPROPRIATION

(Section 2438 of General Statutes, Revision of 1930)

July 1, 1938 to June 30, 1939

RECEIPTS

State Allotment	$9,850.00

DISBURSEMENTS

Personal Services:			
Salaries		$9,000.00	
Contractual Services:			
Travel (meetings, conferences, etc.)	$75.52		
Freight, express and parcel post	5.80		
Gas and electricity	235.79		
Water	32.58		
Repairs to tools, machinery and appliances	4.16		
		353.85	
Supplies and Materials:			
Stationery and office supplies	7.34		
Chemicals and laboratory supplies	229.97		
Photographic supplies	8.04		
Feeding stuffs	114.75		
Miscellaneous supplies	13.63		
Food and drug samples	.65		
Livestock	33.75		
		408.13	
Capital Outlay:			
Library (books and periodicals)		72.13	
Total disbursements			$9,834.11
Balance on hand June 30, 1939			15.89*
			$9,850.00

* Reverted to State Treasury

FEED FUND

July 1, 1938 to June 30, 1939

RECEIPTS

Feed Fees collected by the Station and deposited with the State Treasurer			$20,435.00

DISBURSEMENTS

Personal Services:			
Salaries	$18,990.64		
Labor	42.50		
		$19,033.14	
Contractual Services:			
Travel (outlying investigations)	48.75		
" (meetings, conferences, etc.)	65.29		
Freight, express and parcel post	5.00		
Gas and electricity	313.67		
Water	57.87		
Library (binding)	89.30		
Repairs to automobiles	8.45		
" " buildings	29.09		
		617.42	
Supplies and Materials:			
Stationery and office supplies	5.75		
Chemicals and laboratory supplies	204.26		
Feeding stuffs	177.47		
Miscellaneous supplies	14.46		
Automobile oil	.20		
Livestock	221.25		
		623.39	
Capital Outlay:			
Library (books and periodicals)	50.24		
Tools, machinery and appliances	54.00	104.24	
Total disbursements			$20,378.19
Balance on hand June 30, 1939			56.81*
			$20,435.00

* Reverted to State Treasury

FERTILIZER FUND

July 1, 1938 to June 30, 1939

RECEIPTS

Fertilizer Fees collected by the Station and deposited with the State Treasurer	$12,775.00

DISBURSEMENTS

Personal Services:			
Salaries		$11,410.00	
Contractual Services:			
Travel (outlying investigations)	$65.25		
Freight, express and parcel post	1.43		
Gas and electricity	381.11		
Water	23.89		
Insurance (burglary)	18.56		
Miscellaneous contingent expenses	12.19		
Repairs to furniture and fixtures	2.40		
Repairs to automobiles	1.10		
Repairs to tools, machinery and appliances	25.10		
Library (binding)	57.00		
		588.03	
Supplies and Materials:			
Stationery and office supplies	88.21		
Chemicals and laboratory supplies	311.37		
Miscellaneous supplies	22.88		
Postage	24.25		
Gasoline for automobiles	28.60		
		475.31	
Capital Outlay:			
Library (books and periodicals)	198.80		
Scientific equipment	6.00	204.80	
Total disbursements			$12,678.14
Balance on hand June 30, 1939			96.86*
			$12,775.00

* Reverted to State Treasury

GYPSY MOTH SUPPRESSION APPROPRIATION

(Sections 2131 and 2132 of General Statutes, Revision of 1930)

July 1, 1938 to June 30, 1939

RECEIPTS

Balance on hand July 1, 1938	.....
State Appropriation	$44,880.00
	$44,880.00

DISBURSEMENTS

Personal Services:			
Salaries		$39,011.55	
Contractual Services:			
Telephone	$47.81		
Freight, express and parcel post	.67		
Electricity	15.36		
Insurance	409.83		
Repairs to tools, machinery and appliances	53.25		
" " automobiles	488.85		
Rent of storehouse and office space	420.00		
		1,435.77	
Supplies and Materials:			
Stationery and office supplies	2.62		
Chemicals	.50		
Insecticides	156.00		
Lumber and small hardware	2.99		
Miscellaneous supplies	22.28		
Automobile oil and grease	45.67		
Postage	15.00		
Gasoline	1,022.98		
Fuel	21.86		
		1,289.90	
Capital Outlay:			
Tools, machinery and appliances		385.89	
Total disbursements			$42,123.11
Balance on hand June 30, 1939			2,756.89*
			$44,880.00

* Reverted to State Treasury

BEE DISEASES

(Section 2130 of General Statutes, Revision of 1930)

July 1, 1938 to June 30, 1939

RECEIPTS

State Appropriation	$2,110.00

DISBURSEMENTS

Personal Services:		
Salaries	$1,098.00	
Contractual Services:		
Travel (outlying investigations)	757.95	
Supplies and Materials:		
Stationery and office supplies	9.00	
Total disbursements		$1,864.95
Balance on hand June 30, 1939		245.05*
		$2,110.00

WHITE PINE BLISTER RUST APPROPRIATION

(Section 2126 of General Statutes, Revision of 1930)

July 1, 1938 to June 30, 1939

RECEIPTS

Balance on hand July 1, 1938	.....
State Appropriation	4,900.00
	$4,900.00

DISBURSEMENTS

Personal Services:			
Salaries	$2,130.00		
Labor	1,012.88		
		$3,142.88	
Contractual Services:			
Telegraph and telephone	133.68		
Travel (outlying investigations)	388.90		
Insurance (automobile)	76.01		
Repairs to automobile	109.93		
		708.52	
Supplies and Materials:			
Stationery and office supplies	16.99		
Lumber and small hardware	7.91		
Miscellaneous supplies	32.13		
Gasoline for automobiles	99.09		
		156.12	
Capital Outlay:			
Tools, machinery and appliances		11.10	
Total disbursements			$4,018.62
Balance on hand June 30, 1939			881.38*
			$4,900.00

* Reverted to State Treasury

INSECT PEST APPROPRIATION

(Section 2124 of General Statutes, Revision of 1930)

July 1, 1938 to June 30, 1939

RECEIPTS

Balance on hand July 1, 1938	.....
Insect Pest Allotment	$45,065.40
	$45,065.40

DISBURSEMENTS

Personal Services:			
Salaries	$37,457.48		
Labor	2,103.80		
		$39,561.28	
Contractual Services:			
Telegraph and telephone	235.89		
Travel (outlying investigations)	1,200.36		
" (meetings, conferences, etc.)	100.16		
Freight, express and parcel post	23.30		
Publications (reprints, etc.)	24.40		
Storage of apples	178.96		
Gas and electricity	257.69		
Water	66.97		
Automobile insurance	135.63		
Miscellaneous contingent expenses	29.95		
Repairs to furniture and fixtures	6.00		
" " scientific equipment	34.45		
" " automobiles	210.31		
" " tools, machinery and appliances	17.38		
" " buildings	30.00		
Library (binding)	50.30		
		2,601.75	
Supplies and Materials:			
Stationery and office supplies	131.78		
Chemicals and laboratory supplies	162.79		
Spraying and dusting materials	245.88		
Photographic supplies	37.26		
Miscellaneous supplies	194.80		
Automobile oil	9.09		
Postage	198.96		
Gasoline for automobiles	440.29		
		1,420.85	
Capital Outlay:			
Furniture, furnishings and fixtures	$668.74		
Library (books and periodicals)	265.35		
Scientific equipment	101.88		
Automobile equipment	9.29		
Tools, machinery and appliances	224.99	$1,270.25	
Total disbursements			$44,854.13
Balance on hand June 30, 1939			211.27*
			$45,065.40

* Reverted to State Treasury

MOSQUITO ELIMINATION APPROPRIATION

(Section 2415 and 2416 of General Statutes, Revision of 1930)

July 1, 1938 to June 30, 1939

RECEIPTS

Balance on hand July 1, 1938	.....
State Appropriation	$14,800.00
	$14,800.00

DISBURSEMENTS

Personal Services:			
Salaries	$8,050.00		
Labor	4,388.28		
		$12,438.28	
Contractual Services:			
Telegraph and telephone	13.00		
Travel (outlying investigations)	1,586.90		
" (meetings, conferences, etc.)	63.19		
Transportation of things (other expenses)	17.00		
Rent of equipment	2.00		
Repairs to furniture and fixtures	8.50		
" " tools, machinery and appliances	3.24		
		1,693.83	
Supplies and Materials:			
Stationery and office supplies	2.48		
Spraying and dusting materials	23.62		
Photographic supplies	4.24		
Miscellaneous supplies	66.03		
Postage	3.00		
		99.37	
Capital Outlay:			
Tools, machinery and appliances		210.11	
Total disbursements			$14,441.59
Balance on hand June 30, 1939			358.41*
			$14,800.00

* Reverted to State Treasury

TOBACCO RESEARCH APPROPRIATION

(Section 2123 of General Statutes, Revision of 1930)

July 1, 1938 to June 30, 1939

RECEIPTS

Balance on hand July 1, 1938	.....
State Allotment	$18,166.73
	$18,166.73

DISBURSEMENTS

Personal Services:			
Salaries	$13,600.00		
Labor	1,334.69		
		$14,934.69	
Contractual Services:			
Telegraph and telephone	177.64		
Travel (outlying investigations)	91.25		
" (meetings, conferences, etc.)	201.14		
Freight, express and parcel post	7.35		
Gas and electricity	205.90		
Water	33.18		
Insurance (automobile)	35.38		
Miscellaneous contingent expenses	5.00		
Repairs to automobile	24.90		
" " tools, machinery and appliances	17.17		
" " buildings	25.95		
Library (binding)	39.45		
		864.31	
Supplies and Materials:			
Stationery and office supplies	27.92		
Chemicals and laboratory supplies	114.17		
Spraying and dusting materials	69.76		
Photographic supplies	39.36		
Fertilizers	270.78		
Lumber and small hardware	7.40		
Miscellaneous supplies	80.31		
Automobile oil	13.54		
Gasoline for automobiles	125.38		
Fuel oil	329.30		
		1,077.92	
Capital Outlay:			
Furniture, furnishings and fixtures	115.90		
Library (books and periodicals)	34.76		
Scientific equipment	14.55		
Automobile equipment	393.95		
Tools, machinery and appliances	395.99	955.15	
Total disbursements			$17,832.07
Balance on hand June 30, 1939			334.66*
			$18,166.73

* Reverted to State Treasury

DUTCH ELM DISEASE

(Special Act 498, 1937)

July 1, 1938 to June 30, 1939

RECEIPTS

Balance on hand July 1, 1938			$14,242.50

DISBURSEMENTS

Personal Services:			
Salaries	$5,635.89		
Labor	882.50		
		$6,518.39	
Contractual Services:			
Telegraph and telephone	10.97		
Storage of insects and wood sticks	8.25		
Travel (outlying investigations)	1,368.45		
" (meetings, conferences, etc.)	29.14		
		1,416.81	
Supplies and Materials:			
Stationery and office supplies	49.73		
Miscellaneous supplies	32.67		
Gasoline for automobiles	1.00	83.40	
Total disbursements			8,018.60
Balance on hand June 30, 1939			6,223.90
			$14,242.50

LOCKWOOD TRUST FUND

July 1, 1938 to June 30, 1939

Received from the Trustee and deposited with State Treasurer			$8,648.69

DISBURSEMENTS

Personal Services:			
Salaries	$3,538.17		
Labor	2,991.50		
		$6,529.67	
Contractual Services:			
Shoeing horses	13.95		
Telegraph and telephone	48.85		
Freight, express and parcel post	2.65		
Gas and electricity	78.67		
Water	52.76		
Rent of equipment	4.80		
Insurance (automobile)	160.86		
Miscellaneous contingent expenses	6.00		
Repairs to automobiles	101.51		
" " tools, machinery and appliances	78.82		
" " buildings	79.99		
Nonstructural improvements	4.09		
		632.95	
Supplies and Materials:			
Chemicals and laboratory supplies	20.40		
Spraying and dusting materials	31.50		
Feeding stuffs	55.60		
Fertilizers	735.69		
Lumber and small hardware	12.01		
Miscellaneous supplies	284.56		
Automobile oil	4.25		
Gasoline for truck, tractor and sprayer	151.38		
Fuel Oil	3.50		
		1,298.89	
Capital Outlay:			
Tools, machinery and appliances		52.68	
Total disbursements			8,514.19
Balance held in Trust Fund by the State Treasurer			134.50
			$8,648.69

FEDERAL FUNDS

July 1, 1938 to June 30, 1939

Total Federal Funds received and deposited with the State Treasurer	$54,037.91

DISBURSEMENTS

	Hatch	*Adams*	*Purnell*	*Bankhead-Jones*	
Personal services	$7,500.00	$7,500.00	$26,663.61	$7,983.86	
Contractual services	.....	.....	1,473.09	646.45	
Supplies and materials	.....	.....	1,120.96	293.79	
Capital outlay	.....	.....	742.34	113.81	
	$7,500.00	$7,500.00	$30,000.00	$9,037.91	
Total disbursements					$54,037.91

WHAT THE STATION CAN DO

Each mail brings to the Station requests for information and service, the range of subjects being almost without limit. Every effort is made to comply with these requests, even though they are outside the fields under investigation. This is one of the purposes for which the library is maintained. However, some of the letters request help that requires an intimate knowledge of live stock management and the like, and others ask us to make laboratory determinations for which we do not have the equipment or staff. Therefore it is helpful to publish from time to time a list of the subjects on which we are best equipped to furnish information and the kinds of samples we can accept.

The Station can furnish information on:

Fertilizers and fertilization.
Soils and their management.
The chemical composition of foods, drugs, insecticides and fungicides.
Insect pests of plants and their control.
Fungous and other diseases of plants and their control.
Sprays and spraying.
Fruits and fruit management.
Weeds and their control.
Forestry—all phases.
Care of shade trees, all phases.
Plant breeding.
Lawns, establishment and care.
Bees.
Mosquito elimination.
Tobacco.
Vegetables, especially varieties and strains.

Samples and specimens that can be analyzed, tested or identified:

Fertilizers.
Feeding stuffs.
Foods and drugs.
Milk—except for bacterial count.
Seeds.
Weeds and other plants.
Insects.
Diseased and injured plants.
Soils.

The Station does not furnish information on:

Live stock feeding and management, including poultry.
Animal diseases.
Household management.
Clothing.
Farm management.
Markets and marketing.

Requests for information on these subjects should be sent to the University of Connecticut, Storrs.

The Station cannot make analyses and examinations of:

Drinking water—apply to the Town Health Officer.
Milk for bacterial content—apply to the Dairy and Food Commissioner, Hartford.
Sick or dead poultry should be sent to the Animal Diseases Laboratory, University of Connecticut, Storrs.